THE

ELECTRICAL REVIEW.

VOL. XLV. DECEMBER 29, 1899. No. 1,153

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THE

UNIVERSAL ELECTRICAL DIRECTORY

1900

Edition

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TRAMWAYS AND LIGHT RAILWAYS.

In two years from now, unless continued by special grace, the Light Railways Act will come to an end, for it was only a provisional measure by intention. The whole business of tramways and light railways in this country seems ever to have been enveloped in ignorance, and crushed by ill-advised or ill-drafted measures. The Tramways Act of 1870 rendered impossible the raising of capital, and the Light Railways Act of 1896 has equally failed to secure the results aimed at by its framers. The intention of this Act was to facilitate the construction of light railways, and the gratuitous assumption seems to have been made that because such light railways were needed, because the public demanded their construction and was prepared to find capital to that end, therefore the servants or representatives of the public would necessarily afford all possible facilities to promoters.

But such hopes have been by no means fulfilled. It is a common saying that two are required to make a quarrel. It is equally true that two consents are required to an agreement, but it is lamentable to record that where agreement is called for between a promoter of a scheme and the authority concerned, the intention and meaning of the term agreement has been totally degraded. Where, for example, an electric tramway must of necessity erect poles for carrying the overhead system, the necessity of coming to an agreement as to the position of such poles is used as a means of levying blackmail on promoters. Now, it was not the intention of the Legislature that authorities to be agreed with should set themselves to be wilfully and perversely obstructive. Doubtless, it is annoying for a surveyor of roads who has, perhaps, taken a just pride in what he may call his roads, to see the same torn up by a tramway company. But after all, the roads are not the property of the road surveyors; they belong essentially to the public. If it is to the public interest that a portion of the road shall be occupied by the rails of a tramway or of a light railway, it is the duty of a road surveyor to acquiesce in all necessary works, and not to set up obstruction for the sole purpose of satisfying only personal grievances.

Nor is it only local authorities and their surveyors who have pursued a policy inimical to the public interest. The railway companies themselves, established by the good will of the public, and occupying the country by favour of the public, have largely contributed to hinder the good work of new comers in the field of transportation. These companies, whose special Parliamentary powers have enabled them to build ugly and light-obstructing bridges across public roads, on the plea of convenience to the public, have taken on themselves to use such structures as a means of obstruction to electric tramways.

Here, again, it never was the intention of the Legislature, when permitting such structures to be built, to grant to the then promoters the power to employ such structures as a means for obstructing future developments; developments

as necessary to-day for the public good as were the steam railroads in their early days. Occasionally Parliament does act with some foresight, as, for example, when the Warrington bridge of the London and North-Western Railway was allowed at a low level, with the proviso that it should, when necessary, be raised to permit the passage of vessels. This provision became necessary when the Manchester Ship Canal was made—an undertaking violently opposed by the railway company on the grounds that it would be *impossible to construct it*, and that *when constructed* it would not pay, and no one would use it. Between now and two years hence some consolidation of existing Tramways Acts will surely be effected, this being done, it is to be hoped, with greater foresight than has so far been displayed. The experience gained in electric traction work in connection with the Act of 1896 and the earlier Act of 1870, should enable the public to be better represented before any committee of inquiry that may be constituted as a preliminary to a final Act, than has hitherto been the case. The abuses and blackmail, and the unparalleled delays and obstructions, forced upon promoters, should be rendered impossible.

In electric traction work it is perhaps unfortunate that there must be interference with the roads. Not merely must the permanent way be laid down, but the cables must be trenched in, and the overhead construction must be carried by its poles. As regards these, however, it cannot be claimed that they present so conspicuous an appearance as had been feared. Compared with the big black creosoted poles of the Post Office or of the telephone company, the neat iron poles of a tramway are hardly noticeable, especially as they can always be painted to suit a locality—green, for example, along a leafy road, and red brick colour or stone colour along building routes, according to the nature of the building material; so painted, they are invisible at a short distance. But, in any case, the crying necessity of the day is for better transportation facilities. The country is suffering from great loss of time every day through the lack of better facilities. The industries of the country suffer both directly and indirectly, and millions are being invested abroad for want of profitable investment at home, which would be available for the thousands of miles of necessary tramways, and the collateral industries that would flourish with them. It is, of course, of the greatest importance that proper provision should be made for the due protection of the public interest against future encroachment upon public rights, for these rights have been too much neglected in granting special powers to the railway companies in the past, but it is equally important that Parliament—whose intentions have been in the one case exceeded and in later cases obstructed—should correct such errors in the coming Act. Parliament is all-powerful, and can undo what it has done wherever the public interest demands it. It would be better for the country at large, both on the part of the general public, the inventors, and the commercial and working classes, if no change should be made and no new measures introduced unless it is definitely understood and provided that the electric traction industry is to have fair play; moreover, there must be no short-sighted obstruction on the part of local authorities, or of individual officials arrogating to themselves the ownership of public roads entirely apart from the opinions of the real owners. The country bids fair to be ruined by the restraining hands of men long since gone to dust, through the observance of the letter in matters which may in their time have been in touch with the spirit of the age. Altered conditions nowadays make such restrictions ridiculous.

For example, to take one matter which is for the purposes of to-day as extinct as the dodo—the necessity of paving a tramway track. The obligation to pave the track of a tramway, arose from the extreme wear inevitable where the horses of a tramcar were of necessity compelled always to run along the same narrow line. But to-day it is only through ultra-conservatism that there are any horse tramways at work. Clearly, the enormous expenditure of stone or wood paving ought not to be obligatory along an electric line which has no use for the paving, and causes no wear of it. It seems to us, also, that the obligation enforced upon the Dublin Street Tramways Company of sanding its track, is an unfair obligation. The sand is useless to the tramway company; the tramway track is used by any and every vehicle, and being part of the public road should be sanded by the public authority. True, the sanding of the rail surface might, perhaps, be demanded of the company, but beyond this we see neither sense nor reason in the decision. Future legislation should take into account the use of electricity as at present the chief motive power on tramways and light railways and though anything better than electricity has so far not even appeared in the dimmest distance, we would like not even the next coming motive power to be curbed and obstructed as electricity has been. We venture to say that but for the almost sole recognition of the horse, steam traction would have advanced far beyond what it has done. Steam traction on tramways has never had a chance of showing what it could do. Probably now it never will.

Electric Lighting Loans and the London County Council.

We are not enthusiastic admirers of the London County Council, or of all that it has done in the way of civic control, and in many electrical matters we confess that the attitude of this august body is quite beyond our comprehension. Its method of dealing with such a small matter as the lighting of the Thames Embankment suggested that it was quite beyond its power to deal in a business-like manner with technical matters; while on the subject of tramways it has developed an amazing amount of wrongheadedness. Having regard to these things therefore, it is not surprising that a pretty quarrel should have arisen with the Islington Vestry on the subject of electric lighting loans. One of the functions taken over from the Metropolitan Board of Works was the control of the raising of loans by the London vestries, and from the commencement of its career the County Council has had a good deal to do with loans for the development of electric light works. There have been, at different times, certain matters of difference between Vestries and the London County Council on the subject of lighting loans, but the one with the Islington Vestry, which was related in these columns some two or three weeks ago, is rather suggestive of an attempt to push the prerogative of the Council beyond what was ever intended by Parliament. Following the usual course in developing their electricity works, the Islington Vestry applied to the County Council for sanction to raise a loan for new plant. The Finance Committee, however, insisted upon a complete detailed scheme before they would grant the necessary permission. To our mind the Vestry very properly refused to give what they considered to be unnecessary details; because, as they stated, the estimates had been prepared by the Vestry's electrical engineer, and approved by the Lighting Committee, and the Vestry having confidence in the judgment of both, could not recognise the claim of the Council's officials to be supplied with the details. We may take it that the details were required by the Council in order to see if the Vestry were undertaking a sound scheme; but what member or official of the County Council would have been able to say whether the Vestry's estimate was right or wrong? A consideration of such details would necessitate a certain amount of technical knowledge; and surely the County Council would never dream of submitting an estimate to an outside engineer. Unless they did that, they would be unable to say whether the Islington Vestry's estimates were in order or not. The whole question of the County Council's authority in regard to lighting loans needs to be reconsidered, and the provision which has been made, giving a right of appeal to the Local Government Board in cases where the Council refuse to sanction loans, has not been made too soon.

THE CONTACT v. THE CHEMICAL THEORY OF THE VOLTA EFFECT.

Several circumstances have recently brought into prominence this old and still unsettled controversy. The main question now at issue is the explanation of Volta's classical experiment and of a number of other experiments of a similar kind, though differing in detail, due to him and later physicists. At one time scientific men were divided into two parties by their views on this subject, which were held very strongly and expressed very warmly. Some 20 years ago the British Association made a determined effort to get agreement on the matter by obtaining a clear statement from some competent physicist of the experimental facts, and of the different modes of construing them. By these means it was hoped that the issues might be narrowed and clearly defined, and an end put to a long and irritating flood of loose reasoning and irrelevant experiment which had been poured out by both sides. Prof. Oliver Lodge's report to the British Association, made in 1884 at the Montreal meeting, is the principal document on the subject. To many people this report seemed to be decisive, at any rate against the contact theorists, and it would be difficult to make a clearer statement of the issues. Prof. Lodge's own opinions were given in a categorical series of propositions, expressly designed to challenge a direct negative from those who disagreed with any or all of them. Even this report has not brought the matter to a definite issue, and the Volta centenary has been the occasion of re-opening the whole controversy. The most important recent publication on the subject was Lord Kelvin's lecture, delivered May 21st, 1897, before the Royal Institution. A paper by Mr. Spiers, read before the Physical Society on November 10th last, described a series of difficult and ingenious experiments of the inconclusive character of much of the work on this subject. This paper elicited a short and unsatisfactory discussion, and a promise from Prof. Lodge that he would deal with the question in his next presidential address to the Society.

At one time the theory of the Voltaic cell was inextricably mixed up with that of the Volta effect, and it is clear that they cannot be wholly separated; but recent speculations on the action of the cell, based upon diffusion, are very different from the sort of considerations which have been employed to explain Volta's contact experiments, and have deprived the contact *v.* chemical controversy of much of its interest. We are publishing a translation of Prof. Augusto Righi's account of the theory of the cell, which was appended to his address on the scientific work of Volta, delivered to the Como Conference, and those who are interested will find there a clear general account of Nernst's theory, based on the action of diffusion. One can hardly formulate any statement on the action of Volta's contact effect that would be accepted by both sides, but it seems to be generally thought that the phenomenon is evidence of a statical straining of bodies towards combination, though there is disagreement as to the exact locality or nature of the action.

A peculiar feature of the whole controversy has been that there continually appears to be misunderstanding and confusion between the disputants as to the meaning and use of such terms as potential, and such relations as the one referred to at the Physical Society's meeting, viz., $J\pi = T\frac{dE}{dT}$ as well as to statements of what is actually observed in experiments. Confusion of thought is not to be suggested with Lord Kelvin and Prof. Perry on the one hand, or with Prof. Ayrton and Prof. Lodge on the other; but it is probably the case that words, and the word potential in particular, have been used in different senses at different times. This is especially liable to occur in colloquial discussion, and it is much to be hoped that that likely to ensue on Prof. Lodge's address may be carefully reported and revised by the speakers.

Before describing Volta's experiment the meaning of potential may be referred to. Potential is essentially a property of a position in space, and does not imply that matter exists or does not exist there. It is not a property of matter, and in this way differs in character from such quantities as temperature and velocity. It cannot be measured directly at all, but its value at a point may be deduced from measurements of the electrical force existing in the neighbourhood. These measurements can only be made in fluid media, and the potential of a point within a solid body can only be deduced from observations in the neighbouring fluid medium by means of some assumption. The potential of a point within a solid body has never been measured; and the accepted view that within a conducting body, not conveying a current, it has the same value at all points, has no experimental foundation. Lord Kelvin pointed out in his Royal Institution lecture that this is almost certainly not true of a crystalline metallic structure; and that of the many combatants who have used the term "potential of a conducting body," not one has ever told what he meant by the expression. In Prof. Lodge's Brit. Assoc. Report, 1884, it is stated that Sir William Thomson said that by the expression "potential of a conducting body," he meant "the potential of the medium close to the body." This is a perfectly intelligible and measurable quantity, but evidently it is not the sense which other writers have attributed to the words. The expression "potential at a point" has no ambiguity, but it must be remembered that when the point is within a solid body no value can be assigned to it except by means of some inference which may require careful examination.

The Volta effect may be stated as follows:—

1. If two bodies of different metals are connected metallically a field of electrostatic force is established in their neighbourhood.

2. The density of the field is proportional for any given gaseous medium to the condenser capacity of the system, the surfaces of the two bodies being equipotential surfaces.

3. The metallic connection between the two bodies may be made in any way, and through any series of metals, without affecting the observed field.

A particular case is shown in fig. 1, where a pair of zinc and copper plates, Z Z, C C, forming an ordinary condenser,

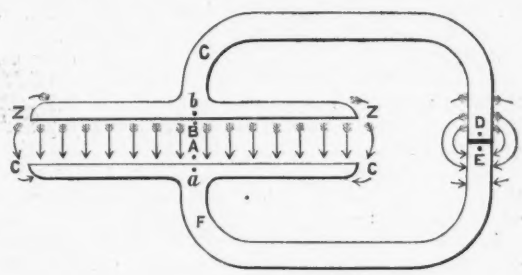


Fig. 1.

are connected by a wire shown partly of zinc, partly of copper, with a junction at D E. Experiment shows that—

1. A positively charged body between the plates experiences a force directed towards the copper plate, and the two plates experience a force tending to bring them together. This last result has recently been obtained directly and satisfactorily by Sig. Q. Majorana. *Phil. Mag.*, September, 1899.

2. The force is inversely proportional to the distance between the plates.

3. The connection C D E F may be made in any way, so long as it is metallic, without altering the field, so long as the surfaces Z Z, C C are unaltered.

If, with Lord Kelvin, the potential of a metallic body means the potential at a point close to and outside it, *e.g.*, A or B, then the above experiment proves that the potentials of the zinc and copper plates in the above experiment differ by a definite amount, which is independent of the form of the structure. (It is a quantity about ·7 volt.) But if the potentials of the bodies mean the potentials at points within them, *e.g.*, (*a*) or (*b*), the conclusion cannot be drawn.

The first step in the arguments drawn from this experiment has been stated in many ways, but all seem reducible to the following:—

(*a*) Experiment shows that a certain quantity of work, W, is done in conveying a positively charged body from a point,

A near the copper, to a point B near the zinc by the path A M B.

(*b*) The work done in conveying a charge by the path A M B is the same as that which would be done in conveying it by the path A *a* F E D C *b* B, which is therefore W.

The question between the two sides is simply as to the part of the path A *a* F E D C *b* B at which the work w is done. According to the contact theory the potential at D is higher than that at E by the same amount as the potential at B is higher than that at A, and the work W is done in conveying the charge from E to D, *i.e.*, across the metallic junction. According to the chemical theory there is no difference of potential between points D and E, but there is between points A and *a*, and between points B and *b*; and the work W is done in conveying the charge across the gas to metal junctions at A *a*, B *b*.

Three observations may be made here :—

1. The character of the surfaces in contact at D E does not affect the field A M B. Suppose, for instance, that the surfaces were separated, the zinc thoroughly burnished, as in Erskine Murray's experiments, and the contact re-made. This is equivalent to inserting in the metallic connecting circuit a plate of burnished zinc, which, in accordance with the experimental results given in Section 3 of the statement of the Volta effect, makes no difference in the force at A M B. This will be generally admitted, though in some experiments the contact surfaces at D E were parts of the surfaces Z Z, C C, and were altered by burnishing, oxidation, polishing, &c.; and it is not clear whether the experimenters supposed that the alteration effected thereby in the force between A and B was due to the change in the surfaces Z Z, C C or in those at D E.

2. The character of the superficial layers of metal Z Z, C C affects the field A M B. Erskine Murray by burnishing, several experimenters by oxidation by heating, and recently Spiers by heating and exhausting the gas, have obtained large changes in the field. These operations introduce changes in the gas to metal junction, and, at the same time, introduce a new metal to metal junction, *e.g.*, between the burnished superficial layer and the unchanged metal beneath it; and it is not possible, *prima facie*, to attribute the effect on the field to one change rather than to the other.

3. The character of the gaseous medium, so far as we are able to test the point by changing it, does not affect the field A M B. Prof. Lodge holds that it would, but that we have no means of making changes sufficiently perfect to show any result.

There are two methods, both due to Lord Kelvin, of determining the contact force of metals which are not open to above objection :—

1. A known quantity of electricity is passed in a continuous current through a metal to metal junction, *e.g.*, from E to D, fig. 1. The heat developed consists of two parts, that due to the resistance of the conductors at a rate proportional to the square of the current, and that due to the difference between the potentials at D and E, at a rate proportional to the current, the latter action being known as the Peltier effect. If a measurement of the heat due to the latter cause showed that the difference between the potentials at D and E was the same as that between A and B, the contact theory would appear to be proved. The sort of quantities that would have to be observed may be shown by the example of fig. 2.

Heat is developed in virtue of the resistance of the conductors in the above arrangement at the rates ·00015 watt per cm. in the copper, and ·00053 watt per cm. in the zinc, sufficient, if there were no radiation, to raise the temperature of the copper at the rate 1° C. in 4·2 minutes, and of the zinc 1° C. in 1·3 minutes. If there were a difference of potential between points on each side of the junction of ·7 volt (suggested by the contact theory) heat would be developed there at the rate of ·7 watt, a quantity many times larger than those which produce the other easily observable effects. The observed results do not approach this, and are decisive, thus Maxwell and Lodge, against the seat of the main Volta effect being at the metallic junction.

2. If a current of electricity i flows along a homogeneous conductor which is not all at the same temperature heat, is developed at each point at a rate H which consists of two parts. One part ρi^2 is the product of the second power of the current by a quantity ρ, the resistance, which depends on the nature of the metal, and on its temperature at the point. The other part σi is the product of the first power of the current and a quantity σ, the specific heat of electricity, which depends on the nature of the metal, on the temperature gradient along the conductor at the point, and the temperature at the point, so that $H = \rho i^2 + \sigma i$.

For large currents the term σi is negligible compared with ρi^2; for small currents ρi^2 is negligible compared with σi. When the difference of temperature between the ends of a metal bar is small, say t, the heat developed by a very small current, i, is $\sigma i t$; and the difference between the potentials at the ends of the bar, due to the temperature gradient, is σt.

→ 1 ampere →

Copper.		Zinc.
·0113	sectional area sq. cm.	·0113
·1	weight grms. per cm.	·108
·00015	resistance, ohms per cm.	·00053
·091	sp.heat.	·091

Fig. 2.

Consider the closed circuit, fig. 2, of two metals whose junctions are at absolute temperatures $T + t$, $T - t$, differing by $2t$ a small quantity; so that T is the mean absolute temperature of each metal. H_{T+t}, H_{T-t} are the electromotive forces of contact at the two junctions; σ_1 σ_2 are the specific heats of electricity of the two metals at the temperature T, so that $2\sigma_1 t$, $2\sigma_2 t$ are the differences of potential between the ends of the conductors due to the temperature gradient along them. Then the electromotive force in the circuit is

$$e = H_{T+t} - H_{T-t} + 2(\sigma_1 - \sigma_2)t.$$

With an electromotive force very nearly equal to e impressed on the circuit (*e.g.*, by a changing magnetic field) so that the current is very small, the whole forms a reversible heat engine, absorbing heat at the hot junction and along one conductor, developing heat at the cool junction and along the other conductor, and doing work equivalent to the difference of the two heats on the magnetic field. The sum of the heats, each divided by the absolute temperature at the point where it is absorbed or developed, is zero (the second law of thermo-dynamics).

Hence $$\frac{H_{T+t}}{T+t} - \frac{H_{T-t}}{T-t} + 2(\sigma_1 - \sigma_2)\frac{t}{T} = 0$$

Since t is small, this reduces to $H_T = T\frac{e}{2t}$.

H_T is electromotive force for the junction of the two metals at the absolute temperature T; e is the electromotive force for the whole circuit of the two given metals at the mean temperature T, with a small difference, $2t$, between the temperatures of the junctions.

This equation is commonly written

$$J\pi = T\frac{dE}{dT}$$

where J is the Joulian equivalent,
π is the measure of the Peltier effect,
E is the thermo-dynamic height of the couple,
T is the absolute temperature.

The value of E and e have been determined for various couples. Prof. Everett (C.G.S. units) gives the value of E for copper-lead $136 + ·95t$ units, and for zinc-lead $234 + 2·40t$ units at $t°$ C. The electromotive force at a zinc-copper junction at 15° C. would be $288 \times 1·45$ units $= 4·2$ microvolts, a quantity much less than that indicated by the preceding argument, and still less comparable with the Volta effect of ·7 volt.

Though both these arguments are due to Lord Kelvin, he is satisfied with the deduction from neither of them of the electromotive force at a metallic junction. The passage in which Maxwell accepted the argument from the Peltier effect as conclusive against the contact theory, was quoted by Lord Kelvin, apparently in strong disapproval, in his printed lecture, and by Prof. Lodge, on the other hand, in his Brit. Assoc. Report in strong approval. The second thermo-dynamic argument is criticised by Lord Kelvin on the ground that the process "involves dissipation of energy by conduction of heat through metals at different temperatures in

different parts," and cannot be treated as a case of a reversible engine. This objection seems to be fatal. It is apparently rejected also by Prof. Lodge (prop. xxi., Brit. Assoc. Report).

Prof. Lodge has been at great pains to make his own views on the matter very clear. He holds that there is a strain towards combination between the atoms on the surface of a metallic body and those of the surrounding medium. In the case of a metal in air, the strain to oxidation tends to draw positive charges towards the surface of the metal, and to repel negative charges. In the case of a body whose surface is uniform, the strain is equal all over, and no external electrostatic field is produced. If the surface is not homogeneous (*e.g.*, partly of zinc and partly of copper), or if different media are opposed to different parts of one surface, the strain is greater at one part than at another, and electrical displacement occurs. The part of the surface which is most readily oxidised, and experiences the greatest strain, becomes positively charged, the less readily oxidisable part negatively charged. In an oxidising medium, such as air, which cannot exchange charges with a metal immersed in it, the space about a non-homogeneous metallic surface is a field of electrostatic force. In the case of an electrolyte where charges can be exchanged with a metal, the medium is a field of electrical current. Prof. Lodge holds that there is no difference of potential between metallic bodies in contact other than the small quantities exhibited by the Peltier effects, but that there is a large difference of potential between points inside the metal and in the surrounding medium. The essential condition of the Volta effect, both in gaseous and liquid media, is a difference of tendency to combination between different parts of the surface of a metallic body and the media adjacent to them. This condition is met either by one medium and different kinds of surface on the metallic body, or by a uniform surface and different media.

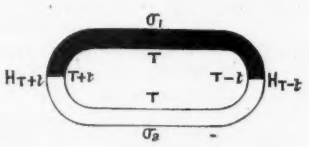


Fig. 3.

On Lodge's theory the Volta effect of any couple should be altered by a change of the gaseous medium, and should disappear in vacuo; and several Volta series calculated for different gases are given in the British Association Report. That the Volta effect is not altered by rarefaction of the air, by replacing it with hydrogen, by protecting the plates with varnish, or by scraping them under paraffin, presents to Lord Kelvin a serious difficulty in accepting the theory, but Prof. Lodge replies to this objection that any known mode of changing the medium near the plates leaves quite sufficient of the original medium to produce the old effect. A number of calculations of the Volta effect, based on the respective heats of combination with oxygen, while they do not in all cases closely correspond with the observed results, certainly do not disprove the theory. Lord Kelvin, on the other hand, looks for the cause of the Volta effect to a straining after combination between the metals of the two plates themselves, and while the effect by Lodge's explanation depends on the heats of combination of, say, zinc and copper with oxygen, Lord Kelvin makes it depend on the heat of formation of brass. He wrote: "This force" (that of attraction between two metals metallically connected) "is a result of chemical affinity between thin surface layers of the two metals; and the work done by it when they are allowed to approach through any distance towards contact between any parts of the surfaces is the dynamical equivalent of the portion of their heat of combination due to the approach towards complete chemical combination constituted by the diminution of distance between the two bodies."

The subject requires reference to one important experiment. In fig. 4 there is no electrostatic field at A, but there is at B.

The supporters of the contact theory supposed that all isolated metallic bodies immersed in an electrolyte are brought to the same potential, and that all uncharged isolated metallic bodies in air are at the same potential, and that a difference of potential is established when they are brought into contact. Prof. Lodge holds that different isolated metallic bodies immersed in an electrolyte or in air, uncharged, are at very different potentials, but are brought to the same potential (less the small Peltier quantity) when they are put in contact.

By the contact theory, in fig. 4 (*a*), the whole system is at one potential, and is uncharged. By Prof. Lodge's theory the three parts, two metals and one electrolyte, are at very different potentials, but remained uncharged, because each metal is strained equally all over, the tendency to oxidation being the same in both oxidising media, water and air.

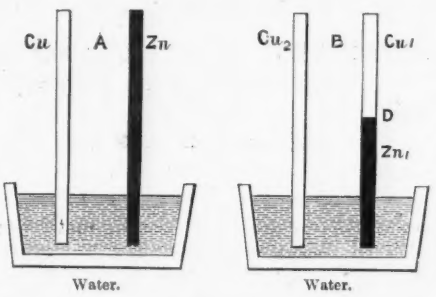


Fig. 4.

In fig. 4 (*b*), by the contact theory, the part Cu_1 is at one potential, being − vely charged, and the remainder of the system, Cu_2, the electrolyte, and Zn_1, are at another potential in consequence of the electromotive force of contact at D, and are + vely charged.

By Prof. Lodge's theory Cu_1 and Zn_1 are at one potential, which is intermediate between those of Cu and Zn in (*a*), Cu_2 is at another potential, and the electrolyte at a third. Cu_1 has a + ve charge, and an equal − ve charge is distributed over the surfaces of Zn_1 Cu_2 and the electrolyte.

The two theories give the same distribution of charges and the same field, so that no observations of the electrostatic forces discriminate between them.

The mode in which the experiment, fig. 4 (*a*) would be explained by Nernst's diffusion theory is not clear.

In conclusion, the following passages may be quoted from English writers on the subject to whom we have referred:—

The electromotive force at the junction of two metals as determined by this method (that of measuring the Peltier effect at a single junction) does not account for Volta's electromotive force. The latter is in general far greater and is sometimes of opposite sign. Hence the assumption that the potential of a metal is to be measured by that of the air in contact with it must be erroneous, and the greater part of Volta's electromotive force must be sought for, not at the junction of the two metals, but at one or both of the surfaces which separate the metals from the air or other medium which forms the third element of the circuit.—Clerk-Maxwell, "Electricity and Magnetism," Vol. i., p. 340, second edition.

In all that precedes I have, by frequent repetition of the phrase "air or ether," carefully kept in view the truth that the dry Volta contact-electricity of metals is, in the main, independent of the character of the insulating medium occupying space around and between the metals concerned in each experiment, and depends essentially on the chemical and physical conditions of molecules of matter in the thin surface stratum between the interior homogeneous metal and the external space, occupied by ether and dry or moist atmospheric air or any gas or vapour which does not violently attack the metal; or by ether with vapours only of mercury and glass and platinum and steel and vaseline (caulking the glass stopcocks), as in Bottomley's experiments.—Lord Kelvin, Royal Institution Lecture, May 21st, 1897, Section 33.

XIX.—A metal is not at the potential of the air touching it, but is always slightly below that potential by an amount roughly proportional to its heat of combustion, and calculable, at any rate approximately, from it. For instance, clean zinc is about 1·8 volts below the air, copper about ·8 volt below, and so on. If an ordinary oxidising medium be substituted for air in the above statement, it makes but little difference.

XX.—Two metals put into contact reduce each other instantly to practically the same potential, and consequently the most oxidisable

one receives from the other a positive charge, the effect of which can be observed electrostatically.

XXI.—There is a slight true contact force at the junction of two metals which prevents their reduction to *exactly* the same potential, but the outstanding difference is small, and varies with temperature. It can be measured thermo-electrically by the Peltier effect, but in no other known way. It is probably entirely independent of surrounding media, metallic or otherwise.

XXII.—If two metals are in contact, the potential of the medium surrounding them is no longer uniform; if a dielectric it is in a state of strain, if an electrolyte it conveys a current.

XXIII.—In the former case the major part of the total difference of potential is related closely to the difference of the potential energies of combination, and is approximately calculable therefrom. In the latter case the total E.M.F. is calculable accurately from the energy of the chemical processes going on, minus or plus the energies concerned in reversible heat effects.—Prof. Oliver Lodge on "The Seat of the Electromotive Forces in the Voltaic Cell," British Association Report, 1884, pp. 519-520.

W. A. P.

THE SCIENTIFIC PRINCIPLES OF PUBLIC LIGHTING BY ARC LAMPS.

By F. W. CARTER, M.A.

(*Concluded from page* 995.)

There is another expression for the horizontal illumination which we shall find useful in considering the effect of varying the height of the lamp, and that is in terms of the distance (B X = d feet, say) from the foot of the lamp. Since $r \sin\theta = \text{B X} = d$, we shall have $r = \dfrac{d}{\sin\theta}$, whence the horizontal illumination $\dfrac{\text{I} \cos\theta}{r^2}$ becomes $\dfrac{\text{I} \cos\theta \sin^2\theta}{d^2}$ candle-feet.

When we are given the curve between I and θ we can find the curves between (i) I $\cos^2\theta$ and θ, (ii) I $\cos^3\theta$ and θ, (iii) I $\cos^2\theta \sin\theta$ and θ, and (iv) I $\cos\theta \sin^2\theta$ and θ, obtaining the points on these curves either by calculation—by multiplying I by the various trigonometrical functions indicated—or, if we prefer it, graphically as follows:—

Let A (fig. 3) be the arc, its axis, A B, being vertical, let P be a point on its photometric curve, so that AP = I and P A B = θ; draw A N_1 vertical and N_1 P_1 perpendicular to A P. Then A N_1 = AP cos θ = I cos θ, A P_1 = A N_1 cos θ = I $\cos^2\theta$, so that P_1 is the point on our first curve (i),

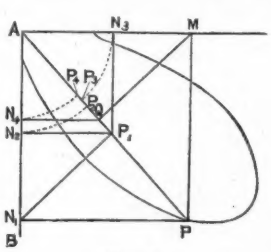


Fig. 3.

corresponding to P. Draw P_1N_2 horizontal, and make A P_2 = A N_2. Then A P_2 = A N_2 = A P_1 cos θ = I $\cos^3\theta$, and P_2 is the corresponding point on curve (ii). Draw P_1N_3 vertical and make A P_3 = A N_3. Then

$$\text{A } P_3 = \text{A } N_3 = \text{A } P_1 \sin\theta = \text{I} \cos^2\theta \sin\theta;$$

thus P_3 is the point required on curve (iii). Lastly, draw PM vertical, MQ perpendicular to A P, Q N_4 horizontal, and make A P_4 = A N_4. Then

$$\text{A } P_4 = \text{A}N_4 = \text{AQ} \cos\theta,$$

and AQ = AM sin θ, whilst A M = A P sin θ = I sin θ,

so that $$\text{A Q} = \text{I} \sin^2\theta,$$

and A P_4 = I $\sin^2\theta$ cos θ. Hence P_4 is the point on our fourth curve. In this way we can get a succession of points on any of the curves.

Let the large polar curve (fig. 4) be the photometric curve of the arc A, and the polar curves (i), (ii) and (iii) be the derived curves so designated in the preceding paragraph. We will, for shortness, call these the curves of total, horizontal and vertical illumination respectively. Draw BX horizontal. Take any point P on the photometric curve, let AP cut BX in N, and the polar curves i, ii, and iii, in P_1, P_2, P_3, respectively. Draw the ordinate at N, and make NQ_1 = AP_1, NQ_2 = AP_2, NQ_3 = AP_3. Repeating this for different positions of the point P, we shall trace out the Cartesian curves marked i, ii, and iii whose ordinates are proportional

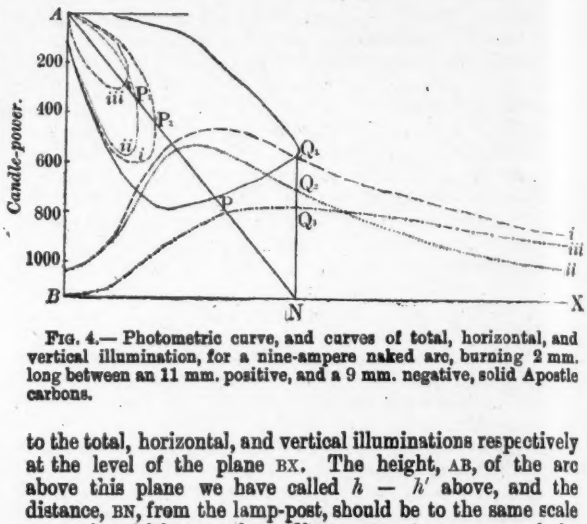


Fig. 4.— Photometric curve, and curves of total, horizontal, and vertical illumination, for a nine-ampere naked arc, burning 2 mm. long between an 11 mm. positive, and a 9 mm. negative, solid Apostle carbons.

to the total, horizontal, and vertical illuminations respectively at the level of the plane BX. The height, AB, of the arc above this plane we have called $h - h'$ above, and the distance, BN, from the lamp-post, should be to the same scale as AB, in which case the ordinate at N to any one of the curves divided by $(h - h')^2$ is the corresponding illumination at N. Thus we can get the particulars of the illumination at any point due to a single lamp. Since we are neglecting reflected light and the influence of other lamps, the illuminations given are, however, too small. The effects of other lamps on the illuminations in question could be found, though, in the cases of the total and vertical illuminations, only by introducing greater complications than the importance of the results justfies. As mentioned above, these illuminations are chiefly important in the neighbourhood of a lamp, where the effects of other lamps is proportionally small. The horizontal illumination at any point, due to a number of lamps, can, however, be easily found, for the separate illuminations of the several lamps have simply to be added. Thus in fig. 5 the outer polar curve at A is the photometric curve of a 12-ampere continuous current Oerlikon arc, with an opaline globe, whilst the inner curve is the derived I $\cos^3\theta$ curve—as is also the polar curve at A′. The height of a lamp is to the distance between them as 21 is to 120—thus they may be taken as 21 feet high and 40 yards apart. To find the illumination of the ground at any point N, join AN, A′N, cutting the I $\cos^3\theta$ curves at P and P′, set up an ordinate QN equal to the sum of AP and A′P′, then QN divided by AB^2 is the illumination at N; thus the illumination at N is proportional to QN. In this way is obtained the Cartesian curve, drawn in the figure, showing the illumination at every point on the line BB′. From the same polar curves we can, graphically, get the curves of equal illumination of the ground, and so study the distribution of light at points not on the line BB′. To do this, we must first describe about A a system of circles having radii in arithmetical progression (*e.g.*, the candle-power circles of the figure). Let any particular circle (*e.g.*, the 260 candle-power circle), cut the I $\cos^3\theta$ curve in P, and let AP cut the ground in N; then at N, and at every point at distance BN from B, the illumination, *due to the lamp at A*, is proportional to AP, *i.e.*, to 260 in our case. Hence, describing a circle about B, of radius BN, we get a curve of equal illumination for the single lamp A. Repeating this for each of the circles about A, we get the series of circles about B, corresponding to illuminations, 560, 540, 520, 500 . . . &c.—(the last six, viz., 60, 50, 40, 30, 20, 10, are separated by intervals of 10, however, in order the better to show the effect of superposing the illumination due to the second lamp). Now describe an exactly similar system of circles about B′, as shown numbered with dashed numbers (10′, 20′, &c.). Where circles of the two systems cut, the illumination due to both lamps is the sum of the numbers attached to the circles. Thus where

30 cuts 10′ the illumination is 40, similarly where 20 cuts 20′, and where 10 cuts 30′. Thus the curve, due to both lamps, corresponding to illumination 40, passes through these points, as is shown in the figure. In this way the system of lines of equal illumination due to both lamps is drawn. We could now introduce a third lamp and obtain such curves for the three if required. These curves really tell us all about the illumination of the ground due to the system of lamps. Where they are close together, the illumination is varying rapidly as we cross them, so that a patch which is nearly uniformly lighted will have but few of these curves upon it.

It will be seen from fig. 5 how very small is the effect of distant lamps compared with the nearer ones. In fact, the illumination at B, due to A′, is about $\frac{1}{2}$ per cent. of that due to A, although the ratio of AB to BB′ is somewhat greater than is usual in street lighting, where the height of the lamps is generally about 20 feet, and the distance between them 50 or 60 yards.

Thus we can find the distribution of light due to a number of lamps placed at given heights and in given positions. Let us now consider the question of the spacing and height of the lamps, when some particulars of the distribution are specified.

We will suppose the lamp to be of given type, *i.e.*. its photometric curve is given. First let the height, h, of the lamp from the ground be given, and the minimum illumination, m, on the line joining two lamps—a suitable specification for street lighting. Let the distance between lamps be x. For a single row of lamps the illumination is a minimum at the centre of BB′ (fig. 5) where it is $2\,\frac{\text{I}\cos^3\theta}{h^2} = m$.

Thus $\text{I}\cos^3\theta = h^2\,\frac{m}{2}$,—a known quantity. From the $\text{I}\cos^3\theta$ curve (fig. 5) we find the value of θ, where $\text{I}\cos^3\theta$ is equal to this known quantity, then $\tan\theta = \frac{x}{2h}$, or $x = 2h\tan\theta$. This gives x.

In practice the value of this minimum illumination lies, in general, between 0·01 and 0·1 candle-feet, according to the importance of the locality, and is usually, in England, about 0·04 candle-feet for principal streets. The minimum illumination of gas-lit side streets appears to be only of the order 0·001 candle-feet.

Taking the actual curve given in fig. 5, let $m = 0{\cdot}06$ candle feet, $h = 20$ feet.

$$\therefore \text{I}\cos^3\theta = 20^2\,\frac{0{\cdot}06}{2} = 400 \times 0{\cdot}03 = 12.$$

This gives $\theta = 74^\circ\ 10'$

$$\tan\theta = 3{\cdot}5 \therefore x = 40 \times 3{\cdot}5 = 140 \text{ feet.}$$

A place of minimum illumination may, with some lamps, occur at B, but it will be so small, and so liable to be lit up by scattered light from the bright zone close outside it, as to be unimportant.

If we are considering the illumination of an open space by an evenly distributed system of lights some small modifications will be necessary in the above.

Thus, if the lamps are staggered, as in fig. 6, we may take the illumination at the centre of any triangle ($A_1\,A_2\,A_3$) as due entirely to the lamps at its corners. Thus, we shall have θ given by

$$m = 3\,\frac{\text{I}\cos^3\theta}{h^2}, \text{ or, } \text{I}\cos^3\theta = h^2\,\frac{m}{3},$$

and $\tan\theta = \frac{OA_1}{h}$, or, if $A_1\,A_2 = x$,

$$x = \sqrt{3} \times OA_1 = \sqrt{3}\,h\tan\theta.$$

If the lamps are in rows, as in fig. 7, the point O is illuminated practically by the four lamps, $A_1\,A_2\,A_3\,A_4$; thus, θ is given by

$$m = 4\,\frac{\text{I}\cos^3\theta}{h^2}, \text{I}\cos^3\theta = h^2\,\frac{m}{4},$$

and $A_1\,A_2 = x = OA_1\,\sqrt{2} = \sqrt{2}\,h\tan\theta$;

so any other case might be treated.

Let us now suppose that the height of the lamp is not specified, but the maximum, (M), as well as the minimum, (m), illuminations of the ground are given.

We may consider the maximum illumination as due entirely to the near lamp. Then, if $\text{I}_1\cos^3\theta_1$ is the maximum radius vector of the curve (fig. 5), we shall have the height of the lamp given by

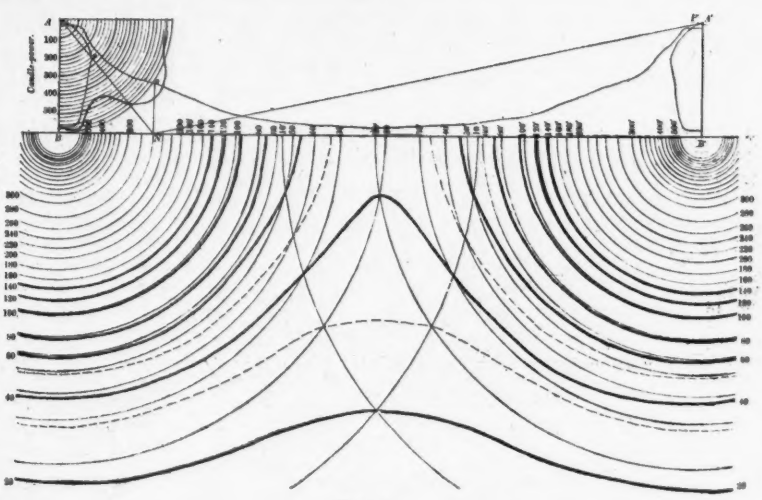


Fig. 5.

$$\frac{\text{I}_1\cos^3\theta_1}{h^2} = \text{M}, \text{ or, } h = \sqrt{\frac{\text{I}_1\cos^3\theta_1}{\text{M}}}.$$

Having found h, we proceed to find the distance between the lamps exactly as in the case just given. The maximum illumination of an arc-lit street is usually between 0·5 and 2 candle-feet.

Thus if $\text{M} = 1$ and $m = 0{\cdot}06$ candle-feet, with the lamp in fig. 5, where the maximum is under the lamp, we shall have

$$\text{I}_1\cos^3\theta_1 = 570$$

$$\therefore \text{H} = \sqrt{570} = 24 \text{ feet approximately.}$$

$$\therefore \text{I}\cos^3\theta = 24^2 \times 0{\cdot}03 = 17{\cdot}1$$

giving $\theta = 72^\circ\ 10'$, $x = 149$ feet or about 50 yards.

A more reasonable case, perhaps, is that in which the average illumination (M′) is given, as well as the minimum (m). To find the average illumination we must divide the total amount of light falling on the ground by the area which it falls on. There is no difficulty in doing this when we are considering the lighting of open spaces, as, in this case, we can divide the ground into as many square, rectangular, triangular, or other areas, as there are lamps. Thus if the lamps are at the corners of triangles of sides x (fig. 6), the area allotted to each is

$$\frac{\sqrt{3}}{4}\,x^2, \text{ thus } \frac{\text{L}}{\frac{\sqrt{3}}{4}\,x^2} = \text{M}',$$

or $$x = \sqrt{\frac{4\,\text{L}}{\sqrt{3}\,\text{M}'}} = 1{\cdot}5\,\sqrt{\frac{\text{L}}{\text{M}'}},$$

where L is the total amount of light given out by each lamp.

If the lamps are at the corners of squares of sides x (fig. 7), each lamp has to illuminate an area x^2.

Thus, $$\text{M}' = \frac{\text{L}}{x^2}, \text{ or } x = \sqrt{\frac{\text{L}}{\text{M}'}}.$$

If, however, the lamps are ranged along a street, some of their light will be wasted on the bordering buildings. This amount will not usually be great and will be partly reflected back on to the street. If we neglect that wasted, and call L still the total amount of light given out by the lamp, and z the width of the street, we have—since xz is the area lighted per lamp,

$$\frac{L}{x\,z} = M', \text{ or } x = \frac{L}{z M'}.$$

This value is somewhat too large, since L should be only the light falling on the street instead of the total light emitted. The wider the street the more nearly correct will be the value of x given by the formula. The quantity L is 2π times the mean hemispherical candle-power of the lamp, taken over the lower hemisphere. We observe that, for a given type of lamp, to have specified the mean illumination, amounts to the same thing as being given the distance, x, between lamps.

The mean illumination of a street lit by arcs usually lies between 0·25 and 1 candle-feet, being generally, in our chief streets, about 0·45 candle-feet. This is, of course, only the part of the illumination due directly to the lamps. In some streets one could rely on its being considerably increased by the presence of shops.

Having found x, we must proceed to find h by making use of the curve between θ and $\text{I} \cos\theta \sin^2\theta$ (No. iv., fig. 3). For street lighting the horizontal illumination half way between two lamps $\left(\text{where } d = \frac{x}{2}\right)$ is

$$m = 2\,\frac{\text{I}\cos\theta\sin^2\theta}{\left(\frac{x}{2}\right)^2},$$

whence $\text{I}\cos\theta\sin^2\theta = \frac{m}{8}x^2$,— a known quantity. Our curve gives us the value of θ which satisfies this.

The height, h, is given by

$$\tan\theta = \frac{x}{2h}, \text{ or } h = \frac{x}{2}\cot\theta.$$

Thus for the curve in fig. 5 the mean hemispherical candle-power = 545 candles, or $L = 2\pi \times 545$.

Let $M' = 0{\cdot}4$ and $m = 0{\cdot}04$ candle-feet, which will correspond to very good lighting, let $z = 50$ feet, $x = \frac{L}{z\,M'} = \frac{2\pi \times 545}{50 \times 0{\cdot}4} = 171$ feet $= 57$ yards, whence $\text{I}\cos\theta\sin^2\theta = \frac{0{\cdot}04}{8} \times 171^2 = 146$.

$$\therefore \theta = 74^\circ\ 10',\ h = \frac{171}{2}\cot 74^\circ\ 10' = 24 \text{ feet}.$$

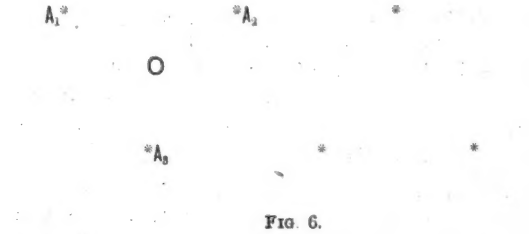


Fig. 6.

Similarly for the open space corresponding to fig. 6, $d = \frac{x}{\sqrt{3}}$, and θ is given by

$$m = 3\,\frac{\text{I}\cos\theta\sin^2\theta}{\frac{x^2}{3}} \text{ or } \text{I}\cos\theta\sin^2\theta = \frac{m}{9}x^2,$$

whence we get $h = \frac{x}{\sqrt{3}}\cot\theta$.

For the second open space considered (fig. 7), we have $d = \frac{x}{\sqrt{2}}$, whilst

$$m = 4\,\frac{\text{I}\cos\theta\sin^2\theta}{\frac{x^2}{2}} \text{ or } \text{I}\cos\theta\sin^2\theta = \frac{m}{8}x^2 \text{ gives } \theta,$$

and

$$h = \frac{x}{\sqrt{2}}\cot\theta \text{ gives } h.$$

Let us next consider the question of the fewest lamps that can be used in order that the illumination of the ground on the line joining the lamps may nowhere be less than m. This is the same as finding when x is greatest. For a single row of lamps we shall have, as in the last problem,

$$m = 2\,\frac{\text{I}\cos\theta\sin^2\theta}{\left(\frac{x}{2}\right)^2}, \text{ or } x^2 = 8\,\frac{\text{I}\cos\theta\sin^2\theta}{m}.$$

Since m is given, x is greatest when $\text{I}\cos\theta\sin^2\theta$ is greatest. Thus we have to find the value of θ, which makes the radius vector in the curve (iv.) fig. 3 greatest. Having found this value from the curve, and x from the formula above, we get the height of the lamp from the formula $h = \frac{x}{2}\cot\theta$. This height will, in general, be very great for street lamps, in the case of such arcs as are at present used. Thus for the lamps in fig. 5, $\text{I}\cos\theta\sin^2\theta$ is greatest when θ is about 54°; its value is then 258 approximately. Thus if $m = 0{\cdot}05$,

$$x^2 = \frac{8}{0{\cdot}05} \times 258 = 4{\cdot}14 \times 10^4,$$

$$\therefore x = 203 \text{ feet} = 68 \text{ yards},$$

$$h = \frac{203}{2}\cot 54^\circ = 74 \text{ feet},$$

which height is impracticable for street lighting with the lamps in question, and with minimum illumination 0·05. In fact the lamps must have their photometric curves with maxima very little below the horizontal for this method to lead to feasible results, unless the minimum illumination is to be very high. For the arrangement of lamps in fig. 6 we shall have

$$x^2 = 9\,\frac{\text{I}\cos\theta\sin^2\theta}{m}, \text{ and } h = \frac{x}{\sqrt{3}}\cot\theta;$$

whilst for the arrangement in fig. 7, $x^2 = 8\,\frac{\text{I}\cos\theta\sin^2\theta}{m}$, and $h = \frac{x}{\sqrt{2}}\cot\theta$, where, it must be remembered, θ is the angle at which $\text{I}\cos\theta\sin^2\theta$ is greatest.

Uniformity of illumination can hardly be hoped for when such large sources of light as arcs are used; nevertheless the conditions tending to uniformity may be elucidated. If the lamp-posts are given in position, and we suppose all the arcs raised gradually we shall find that, as the lamps mount higher, the maximum illumination of the ground diminishes,

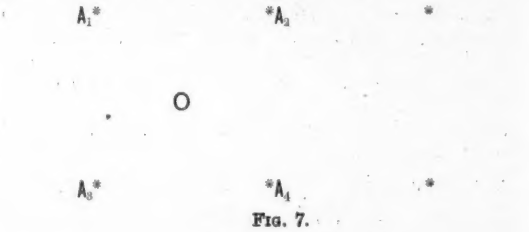


Fig. 7.

whilst the minimum for a time increases, and then begins to diminish. The turning point—when the minimum illumination is at its greatest—may be taken as giving the superior limit practicable to the height, which, in fact, will generally be found higher than is usual at present, unless very good lighting is required, so that the distance between lamps is small. For a single row of lamps,

$$m = 2\,\frac{\text{I}\cos\theta\sin^2\theta}{\frac{x^2}{4}};$$

where x is given, m is greatest when $\text{I}\cos\theta\sin^2\theta$ is greatest, and having found θ to make this as great as possible, we have $h = \frac{x}{2}\cot\theta$. In fact, this problem is the same as the preceding one, except that x is now given instead of m. To be given x is, as shown above, the same as being given the mean illumination, M'.

Perhaps a more practical discussion of uniformity which, however, only applies when we have a minimum illumination, not zero, under the lamps, as well as one between them, is based on the consideration that if we increase one mini-

mum, we shall, for a time at any rate, diminish the other, and *vice versâ*. Under such circumstances we shall have an approach to uniformity if we make both kinds of minima equal. Thus for a single row of lamps,

$$m = \frac{I_0}{h^2} = 2\,\frac{I\cos^3\theta}{h^2},$$

where

$$\tan\theta = \frac{x}{2h},$$

and I_0 is the intensity vertically downwards. Hence we have to find the value of θ which makes $I\cos^3\theta = \frac{1}{2}I_0$ (fig. 3, curve ii). If the minimum illumination is given,

$$h \text{ is given by } m = \frac{I_0}{h^2}, \qquad \text{or } h = \sqrt{\frac{I_0}{m}},$$

whilst x is given by $x = 2h\tan\theta$.

If the height, h, of the lamp is given, the minimum illumination is found from $m = \frac{I_0}{h^2}$, and x is given by $x = 2h\tan\theta$. If the distance, x, between the lamps is given, we shall have $h = \frac{x}{2}\cot\theta$, and the minimum illumination is given by

$$m = 2\,\frac{I\cos^3\theta}{h^2} = 8\,\frac{I\cos\theta\sin^2\theta}{x^2}.$$

In fig. 4, for instance, $2I\cos^3\theta = I_0$ when $\theta = 66{\cdot}5°$ about, whence $x = 2h\tan\theta = 4{\cdot}6\,h$. If then the minimum illumination, m, is specified as, say, 0·06 candle-feet, we shall have

$$h^2 = \frac{I_0}{m} = \frac{120}{0{\cdot}06} = 2{,}000$$

$$\therefore\ h = 45 \text{ feet},$$

and $x = 207$ feet $= 69$ yards.

The maximum illumination is only 0·31 candle-feet, so that the contrast between brightness and darkness is much smaller than usual.

The foregoing methods, even when leading to impracticable results, may suggest improvements in arc lamp globes and reflectors. Usually, with such large sources, there is plenty of light in the neighbourhood of a lamp, and it is the dark space between lamps that requires attention. Here the illumination can be increased either by raising the lamps or by using such a lantern and reflector as will send out the greater part of the light but little below the horizontal. For the lighting of open spaces both are feasible; the second alternative being perhaps the better from a photometric point of view, since very high lamps give bad illumination of vertical objects near them. For streets, however, unless they be very wide, both are objectionable as wasting a lot of light on adjacent buildings which might have been more usefully employed, so that, unless very high illumination is required, we must be content with a less uniform distribution of light than is possible in an open space.

One would like to see manufacturers of arc lamps generally introducing the photometric curves of their lamps—running precisely under working conditions—into their catalogues. The derived system of circles of equal illumination would also be useful, together with a table giving the product of the minimum illumination due to two lamps and the square of their height (*i.e.*, $2I\cos^3\theta$), for different values of the ratio of the distance between the lamps to the height of a lamp.

Wigan.—On Wednesday last week the Mayor (Mr. Alderman Gee) switched on the electric current for the first time at the temporary central supply station. Mr. H. Collings Bishop, the electrical engineer, had to find a suitable temporary site, and hire plant. This he has done, the plant consisting of a Robey undertype steam engine of 100 H.P., and the dynamo a Byng-Hawkins of 240 amperes and 250 volts, and with this plant he is furnishing power for upwards of 1,800 lamps. He accomplished a creditable work in supplying the light before Christmas, as promised. We hear that Mr. E. H. Johnson, A.I.E.E., has installed the light at the Victoria Hotel, Victoria Vaults, Dog and Partridge Hotel, Shakespeare Hotel, &c.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

METHODS OF SUPPRESSING ARCS IN SWITCHES, FUSES, &c.

By Ernest Kilburn Scott, A.M.I.C.E.

(*Read at Manchester, Tuesday, December 5th.*)

(*Concluded from page* 1022.)

Ferranti Oil Fuse.—One of the most ingenious devices for suppressing high-tension arcs is the Ferranti oil fuse. This consists of a rectangular porcelain vessel containing resin oil to a depth of several inches. It is divided lengthways into two compartments, and in each there is a spring which, when at rest, has its free end resting on the bottom of the vessel. To set the fuse, the free ends of the two

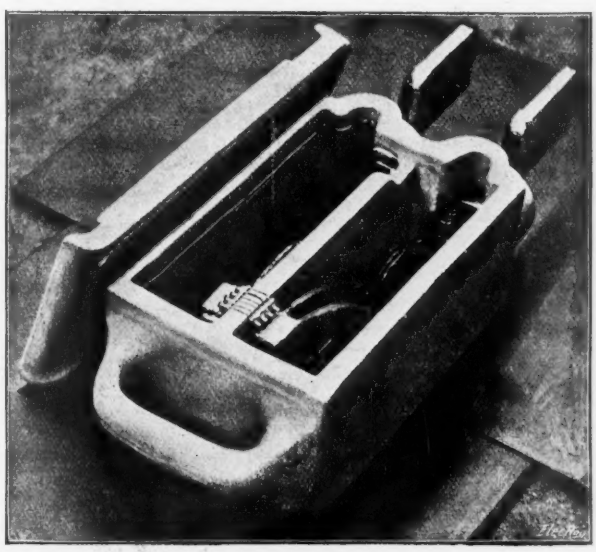


Fig. 16.—Ferranti Oil Break Fuse.

springs are raised up until they are clear of the oil, fuse wires are attached from terminal to terminal, their middle portion resting on the dividing porcelain partition, as shown in figs. 16 and 17. Naturally, when an excess current passes the wire melts, releasing the two springs, which plunge down through the oil on both sides, and thus put out the arc. This arrangement will satisfactorily break 500 amperes at 5,000 volts, and it forms one of the most important details in the successful Ferranti switch panel. It may be mentioned that on the Continent for extra high tension switches it is quite the usual arrangement to make the final break under oil.

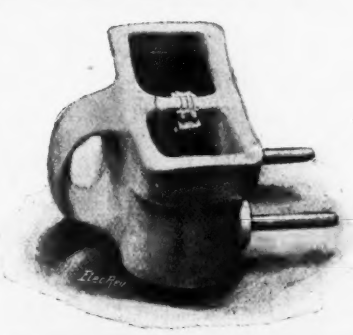


Fig. 17.—Ferranti Oil Fuse. (Small size for transformers.)

Verity & Steele's Oil Fuse.—A high tension fuse has been recently introduced by Veritys, Limited, which is more or less on the lines of Mr. Ferranti's device, in that the broken end of the fuse wire is submerged in oil, gravity taking the place of the springs used in the original type. The 50 amperes size is shown in fig. 18, from which it will be seen that the fuse wire is passed through a U-shaped glass tube. On excess of current the wire fuses in air at the point C (the opposite end, B, being thickened up by having an extra strand wrapped round it), and the tube with the oil in it immediately drops, the broken end of the fuse wire being drawn under the oil at double the rate of travel of the tube.

Spring Back Fuse.—A somewhat similar idea used in America is

shown in fig. 19. The fuse, made of sheet metal, is in a state of tension between two hinged terminals, which are pulled apart by springs. Around the central portion of the fuse the porcelain blocks

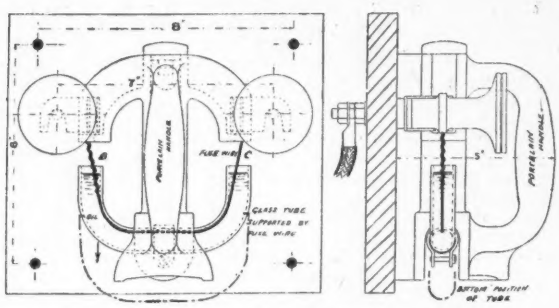


Fig. 18.—Verity & Steele's Oil Break Fuse.

are recessed so as to provide an air chamber, which is vented through the hole in the upper block. As the fuse loses its tensile strength at a low red heat, it is pulled apart almost before the metal has had time to melt, with the result that very little of the metal is volatilised. With a fuse of this type occupying only 6 inches × 3 inches, Mr. W. L. R. Emmett says he has repeatedly broken 300 amperes at 13,000 volts without injury to the device.

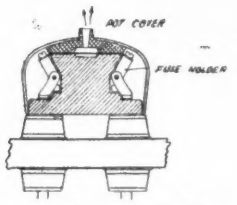


Fig. 19.—Spring Back Fuse.

The very ingenious "time fuse" made by Messrs. F. H. Royce and Co., in which a resistance coil heats up the fuse wire, is also provided with a spring, which draws the ends of the wire apart directly it is melted.

Shunted Fuse Working by Gravity.—The writer has suggested a combination of the shunted fuse with this springing back of the terminals. The arrangement is shown in fig. 20 applied to a high tension transmission of power line. The heavy fusible alloy which ordinarily carries the greater portion of the current is plugged in between the two lower terminals, whilst the shunt consisting of a fine copper wire connects the two upper terminals. These are hinged

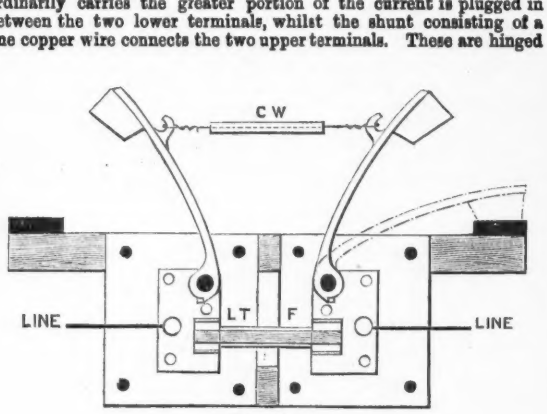


Fig. 20.

and weighted so that directly the copper wire melts by having the main current shunted through it, they fall back into the dotted position. Any arcing that may occur will soon go out, because the hot air tends to make it rise as in the exceedingly simple but effective Siemens & Halske lightning arrester, which works entirely by the arc creeping up two (or three for three-phase) curved arms and gradually lengthening until it flickers out.

Part III.—Non-Arcing Metals, &c.

The perfect non-arcing metal would be one having no resistance, for then there would be no heating of the final point of contact, and consequently the arc would not start. This is of course impossible, and therefore the term non-arcing metals is always taken to mean metal which on commencing to arc gives off a vapour which forms an exceedingly high resistance.

The Wurts Non-arcing Arrester.—As the result of most exhaustive researches Mr. Wurts found that certain particular metals and combinations of metals—the most important being zinc and antimony—gave a non-arcing effect when the distance between the metal was only $\frac{1}{32}$nd of an inch (see fig. 21). Various explanations are offered to account for this non-arcing property, but the one most generally

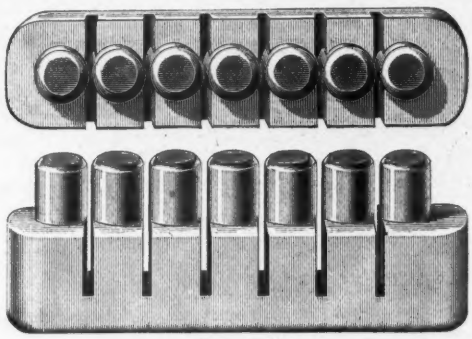


Fig. 21.

accepted is that the metals immediately produce a non-conducting oxide vapour over which the current cannot pass.

It has been thought that besides the non-arcing property of the alloy, the considerable mass of metal which is necessary for the rollers has a beneficial effect in cooling off the small arcs produced.

A peculiar feature in connection with the device is that if the spark gaps are long, say $\frac{1}{2}$ inch each, most vicious arcing will occur, probably because the oxide vapour has a much better chance of being dissipated.

Although originally introduced for the purpose of being applied to lightning arresters, it involves a principle of suppressing arcs, which the writer believes will some day have a much wider application. In the discussion on Mr. Byng's paper before the Institution of Electrical Engineers, the writer suggested the application of the idea to switches, and it is interesting to note that this has now been tried with satisfactory results.

Müller Non-Arcing Switch.—Mr. H. Müller, of the Electricitäts Actiengesellschaft, late Schuckert & Co., has designed a high tension switch for alternating current, in which the Wurts non-arcing device is introduced. It consists of 16 small rollers (see fig. 22) of non-

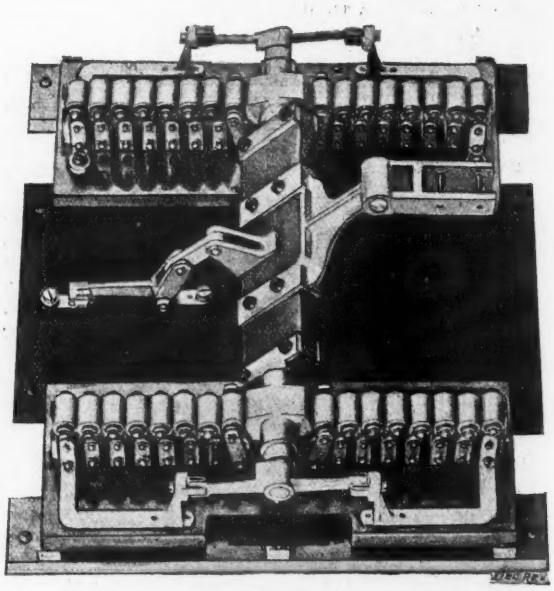
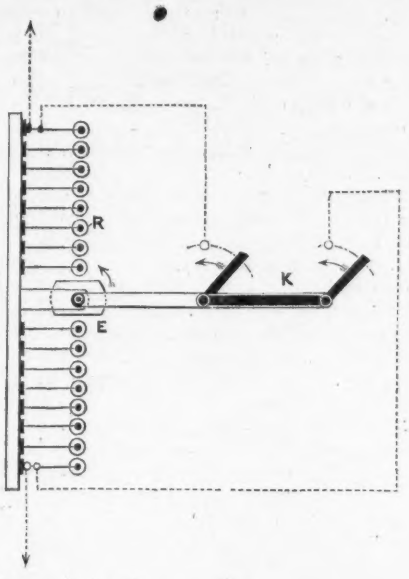


Fig. 22.

arcing metal, having spaces of 1 to 1½ mm. between them. When the switch is made, a cam comes between the two sets of rollers and forces them all into contact, at the same time rotating the rollers slightly, causing new faces to be brought into contact, and rubbing off any oxide which may have been produced. These switches will break 6,000 volts with very slight sparking, and they have been in use for some time in the municipal lighting station at Nurnberg, working with 2,000 volts 150 amperes. As the rollers are not very good conductors, for extra large current the rollers are used as a final break to an ordinary switch of the hatchet pattern, connected to the same cam which actuates the rollers. In switching on the rollers are first connected up, and then the main switch, and when the latter is home it takes all the current (see fig. 23).

Aluminium, Platinum, &c.—Experience with aluminium has been so favourable, that it is now used almost exclusively for high tension fuse wires in America, and it is possible that this preference may be due to its forming a non-arcing oxide. In a power transmission line in South California, working at 33,000 volts, the fuse wires are of

No. 20 gauge pure aluminium wire. They are 3 feet long, and run through wooden tubes, on the ends of which hatchet contacts are fixed, which can be quickly removed for re-fusing. On another plant working with 10,000 volts, an aluminium fuse wire about 1 foot long is



stretched horizontally, the wire being surrounded by a soft rubber tube. When the fuse goes, this tube drops by its own weight, carrying with it the molten metal and giving a clean break.

It is interesting to note that some metals do not readily oxidise with an arc. Platinum oxides, for example, can only be made by the wet process, and they are at once dissociated by the application of heat. Platinum is thus, in a sense, a non-arcing metal; its efficacy, when used as a final breaking point of switches, &c., is well known.

Part IV.—Conclusion.

Many suggestions have been made which have not been put into practice, thus one idea is that the fuse wire should have attached to it a small cap which will explode when the wire melts and thus dissipate the metallic vapours. Another suggestion is that the wire should be covered with some material which would combine with the metal to form a heavy insulating gas.

It has also been suggested that the fuse be surrounded by carbon dioxide gas, which ordinarily will not support combustion. This would not be much good with the electric arc, however, because we know from experience that an enclosed arc lamp or semi-enclosed arc lamp,* as it really is, burns well in an atmosphere consisting mainly of carbon dioxide gas.

In 1894 Mr. J. Sachs suggested burying the fuse wire in a chemical salt, which would combine with the metal of the fuse when heated. Something of the sort might be done, but there would always be the danger that its carrying capacity might be lessened, due to the salt attacking the metal when it was only warm.

A curious development of the difficulty in dealing with the large amounts of current at extra high voltages on transmission of power lines, is the suggestion to do away with safety devices altogether. It has long been known that certain types of alternators could be so designed that they would withstand considerable overloading without showing evil effects. It appears that American engineers are now going further in this direction, and actually designing multiphase alternators for transmission of power work, with the sole idea of their being able to withstand short-circuiting, so that when a fault occurs on the line a large current is passed sufficient to burn it out. The change is not so drastic as it appears at first sight, because the writer understands it has been the practice in this city for some time to burn out any faults which may occur on the underground continuous current cables.

Manchester and Liverpool.—The Irlam District Council has decided not to give its assent to the Bill promoted for the construction of the proposed electric railway between Manchester and Liverpool. As it is proposed to alter the gradients of some of the roads in the township, the Council desires to obtain a *locus standi* in the matter.

* As there appears to be some misconception on the point it may be mentioned that an *entirely* enclosed arc will not work satisfactorily. Directly every particle of free oxygen has been burnt up the carbons begin to pump violently and a steady arc is out of the question however much the mechanism may be adjusted.

COMBINED REFUSE DESTRUCTORS AND ELECTRIC LIGHTING PLANTS.

The meetings held at the Institution of Civil Engineers on Tuesdays, December 12th and 19th, have again brought the question of combined refuse destructors and electric light installations to the front.

The occasion was the reading of a paper by Mr. C. Newton Russell, its subject being "Combined Refuse Destructor and Power Plant," and its object lesson "Shoreditch Works." A brief abstract was published in the Electrical Review for December 22nd.

As a preliminary remark, we congratulate Mr. Russell upon the clear and explicit statements set forth, although our deductions may be somewhat different from his own.

Our readers will bear in mind that some two years since the question was discussed again and again in these columns, and we then expressed a doubt as to the advisability of thus combining two distinct undertakings, although the plea of economy is one which is undoubtedly a favourite topic with the faddists who are to be found on most of our vestries and district councils.

The perusal of this paper does not in the slightest degree alter the opinion we then formed, viz, that a well-constructed destructor and a well-designed electrical installation would work better if each were independent of the other, than any scheme of combination such as that in operation at Shoreditch.

In the paper itself there was nothing new, or beyond that which had already been put forth in detail, but it has the merit of being fairly concise, and of bringing into a readable form its various details.

The discussion which ensued was of an interesting character, and the gentlemen who took part were well alive to the importance of the subject, and were practically acquainted with it.

Mr. Laws, engineer of the Newcastle Corporation; Mr. Charles Jones, of Ealing; Mr. Blair, of St. Pancras; Mr. Terry, late Local Government Board inspector; a representative from Oldham; Messrs. Manville, Alliott and Beaman; Mr. Watson, of the Horsfall Company; and Mr. A. H. Preece, all added something to the general interest of the occasion, but we could not gather from anyone of them (other than they who were absolutely connected with Shoreditch) any very marked approval of the scheme, and although there was a decided approval of the character of the work as carried out, we could not help coming to the conclusion from the evidence of the great majority of these practical men, that the consensus of their opinions was that a large expenditure had been made on the capital account, and a very considerable expense was being incurred upon the current account. Therefore outlays were not justified by results, or, to put it in plain language, the game was not worth the candle.

The remarks of Mr. A. H. Preece were very interesting, he having been connected with the installation at Llandudno, and nothing could more thoroughly justify our opinion as to the desirability of the destructor and the electric light installation being absolutely distinct than the experience detailed by him of the Llandudno combination during the short period which has elapsed since its erection. The destructor in this case appears to have been designed for a town with a population certainly considerably larger than Llandudno, even when its influx of visitors is at its maximum. The admission that the destructor furnaces were let out at night in consequence of there not being sufficient material to burn (to say nothing of the admitted use of coal) shows an exceedingly weak point in the arrangement of the same, for anyone connected with the working of such undertakings knows full well that one of the essential points is that the combustion should go on night and day, year in and year out, excepting when it is absolutely necessary to shut down in order to repair.

Touching upon the several details of the work as set forth in the paper, we admit that time has to some extent proved the correctness of the statements made with respect to combustion of coals as an addition to the power derived from the combustion of house refuse, but the fact that some £1,308 was spent during the year ended March, 1899, is somewhat startling when we remember the language used in the early stages of this discussion, and when we suggested that it would

be necessary to use a certain amount of coal, which would be better utilised in a boiler properly constructed, where advantage could be taken of its full calorific value.

The fact that a considerable amount of steam-raising property exists in house refuse has never been denied, but from the remarks made by Lord Kelvin at the opening ceremony, and repeated by him during his journey in the United States, it might be supposed Shoreditch was the first place that ever attempted to utilise house refuse. Probably, notwithstanding his extensive knowledge, Lord Kelvin was unaware, at the time, that destructors were a comparatively old institution in England, at any rate, some 30 years old, and that, from the very first, they had been used for steam-raising purposes.

We will not refer to the now historical banquet held at the opening of the destructor, to the "turning out of the old light and the turning on of the new," &c., nor to the dedicatory prayer of the esteemed Vicar of Shoreditch, but we regret the fact (referred to by Mr. Charles Jones in the discussion) that the remarks then made by such an authority tend largely to mislead many who are honestly desirous of utilising the waste material of their cities and towns. Many of these municipal men would be led into extravagance in the construction of an apparatus which, while suitable for a district such as Shoreditch, with its crowded population, would be in nowise suitable for a large majority of towns whose sanitary requirements are as great as those of Shoreditch, but whose means of meeting the same are far more limited.

Upon one question there can be no shadow of a doubt, that the installation in its entirety was a most expensive one, and that the cost of the destruction of refuse is immensely higher than in any other place in England. By referring to the tables in Mr. Charles Jones's book on "Refuse Destructors," published in 1894, we find that the expense incurred in destroying refuse is represented as varying from 3½d. to 1s. 7d. per ton, about 10d. being a fair average.

According to Mr. Russell's paper, at Shoreditch the cost may be taken at 2s. 7d. per ton, to which must be added 11½d. per ton for the repayment of principal and interest extending over 30 years, bringing it, in round figures, to 3s. 6½d. per ton.

Surely this is a serious item, more especially as it must of necessity extend over a long period of years. We note that the average term at Shoreditch is 30 years.

Now, if 10d. or 1s. may be taken as the average cost of the destruction of refuse per ton, and the remaining 2s. 6½d. had been devoted to coals, surely it goes a long way to prove our statement that these installations would be far better if independent one of the other, and so avoid the uncertainty which evidently appertains to the use of house refuse for steam-raising purposes.

We do not say that house refuse should not be utilised. There are many other purposes, not requiring so careful and scientific a treatment as electric lighting, where it might well be employed with advantage.

With reference to the "thermal storage," about which so much was said, and with which so little has been done, we have still less to say. Although un-utilised for a considerable period *after* the opening of the works, it appears now to be used to a certain degree, but notwithstanding that the term "thermal storage" is still used in connection with it, it appears to us to be very little more than a somewhat extravagantly sized hot water cistern, and we have very considerable doubt as to whether we shall find it in any further scheme which may be evolved from the brains of the designers of the Shoreditch installation.

The speakers had experience of both low temperature and high temperature. Mr. Laws had experience of low temperature only, and he spoke most highly of its usefulness in the town of Newcastle. Mr. Charles Jones has always been considered the champion of low temperature cells, but we find that he has a combination, and he spoke highly of the effect of his last-constructed cell which, by-the-bye, we had never heard of before, and which he evidently has kept very quiet until the time came for making it known.

The question of the character of the refuse was hardly touched upon. We regret this somewhat, for, as Mr. Russell states, the fact of Shoreditch being a large cabinet-making factory, or, in other words, that a very large proportion of its inhabitants are engaged in that trade, undoubtedly is supposed to give the key to the value of the refuse, but we note that in the appendix, he states that only 5 per cent. of the entire quantity can be taken as trade refuse. We do not doubt for a single moment Mr. Russell's statement, yet, at the same time, when we notice the large amount of motive power used, and that in cabinet-making works, we ask how it can be proved that only 5 per cent. is other than house refuse, and this detail is, we think, rather difficult to explain.

The question has, undoubtedly, a considerable bearing upon what Mr. Russell terms the "result of the experience gained at Shoreditch."

We doubt very much whether the domestic house refuse in London has, as alleged, a calorific value equal to 1 lb. water to 1 lb. refuse burnt, and certainly, if he includes greater London in the category, we say absolutely that such a thing cannot be. Taking seasons, such as the last three summer seasons, we believe that in greater London the refuse has been comparatively valueless, arising from the fact that the summer heat, to a great extent, minimised the combustion of coal. This statement we make on indisputable testimony.

No. 2 of his results goes to prove that in London domestic refuse can be destroyed for "2s. 5d. per ton." We know that it can be destroyed at less than one-half that price in properly and economically constructed cells.

We cannot see our way to agree with Mr. Russell in his third "experience," that if the whole of the refuse of London were burnt in suitably constructed furnaces there could be obtained from it 133,000,000 B.H.P.-hours!!!

"Experience" No. 4, with respect to one boiler and two furnaces in good condition, has too much the character of an advertisement for us to make any remark upon it.

Again congratulating Mr. Russell upon having at last produced a clear and explicit account of all the work done at Shoreditch, its successes and failures, we wish him every success, and hope that he may in the end produce results which will be more satisfactory to himself and to the pockets of the ratepayers of Shoreditch.

The lateness of the hour precluded Mr. Russell's reply; this, we believe, will appear in the *Proceedings* of the Institution.

MUNICIPAL EXTRAVAGANCE.

The publication of the Parliamentary aspirations of the West Ham Corporation ought to make that body immortal in the annals of municipal extravagance. The mere summary of the works contemplated occupies 17½ closely printed columns in the *London Gazette* of November 24th. The estimated cost is not, of course, at present disclosed. Equally the summary exhibits the presence of the pernicious socialistic ideas, the petty grasping after power, the resentment against checks upon excessive expenditure, and the general condition of "swelled head," which have so frequently rendered similar authorities the laughing-stock and, withal, the enemy of the business man.

One might have thought, however, that any corporation situated in such an essentially commercial district, would have been reasonably satisfied with their previous efforts, content to proceed at a moderate pace, and careful of the interests of the large ratepayers, lest perchance they should kill the goose which lays the golden eggs. But our unfortunate experience of local authorities leads us to expect nothing of the sort. On the contrary, that "Appetite grows by what it feeds on" was never more fatally illustrated than in the financial career of these bodies. They can digest any amount of public expenditure and always desire more.

The members constituting the local authority in a commercial district are not always, we had almost said not usually, people of much consequence by reason of any great activity displayed or success obtained by them in their own business. Nor are they usually conspicuous for the large sums which they contribute in the shape of rates towards the public expenditure upon which they so lightly embark. Where the bulk of the electors are working men, representatives of this kind, and with these ideas and characteristics,

are usually elected. And then there is the fascination of spending money—other people's money—a fascination which comes with multiplied force to a man who has never had very much of his own. To see every road up, many buildings down, and a huge area covered with bricks and mortar, affords a sense of power and consequence to the class of mind with which the individuals who project these gigantic and extravagant public works are usually endowed. Of course hundreds of electors are thus provided with occupations at which they can work leisurely at comfortable wages. And so satisfaction—except in the breasts of the ratepayers—reigns supreme.

Turning to the summary, we find that the first 17 items of this preposterous programme relate to the widening of some 20 thoroughfares, and the construction of three new roads, one of which is to involve a bridge over the channel-sea river. This is a pretty good mouthful to begin with, but it fades into insignificance by the side of the other morsels presented for the ratepayers' delectation.

The next item looks innocent enough at first sight. The Corporation desire to be empowered to erect, maintain, and work stations (in addition to the existing station) for generating and distributing electrical energy, with all necessary dynamos, batteries, accumulators, engines, plant, machinery, works, and conveniences for that purpose. This power, however, does not appear to be desired in order that the borough may be better lighted. Its true purpose is to be found in connection with the elaborate tramway system which the Corporation wish to create. This egregious body propose in the Bill to obtain power to lay down, work, use, and maintain *eleven* tramways, with "all necessary and proper rails, plates, sleepers, channels, junctions, turn-tables, turnouts, crossings, &c." The motive power to be used is declared to be, *inter alia*, electrical, and the Corporation are asking the Legislature "to alter and amend the provisions of the West Ham Electric Lighting Order, 1892, and to enable the Corporation to utilise electrical power generated under the powers of that order for the purposes of any of the tramways proposed to be authorised by the Bill." No wonder fresh generating stations will be required! And how much is all this to cost?

It will be seen that the enterprise of the Corporation is by no means confined to their own district, which is evidently much too cramped, in the opinion of these gentry, to afford a proper theatre for the display of their "improving mania." The urban district of Leyton is to be invaded for the purpose of widening streets and erecting artisans' dwellings. The urban district of East Ham is to be invaded by "Tramway No. 11." And the Corporation desire to be exempted in regard to any portion of the intended tramways which will be situate outside the county borough, from the provisions of the Tramways Act of 1870, with respect to the purchase of tramways by local authorities. That is, the Corporation wish to purchase and run, out of their own rates, a tramway situated out of their district! It is, indeed, fortunate that there are statutory safeguards which such municipal madness has to reckon with.

Is there *any* territorial limit to the ambition of the West Ham dignitaries? We, ourselves, can assign none, seeing that the Corporation already appear to regard the whole county of Essex as their lawful prey.

It must be remembered that the Corporation are seeking compulsory powers of acquiring lands for the purposes of their schemes. And they are asking Parliament for authority to purchase "so much only of any house, building, manufactory, or property as may be required for the purposes of the Bill." This affords a cheerful prospect to any unfortunate manufacturer whose premises are thus to be arbitrarily encroached upon. The inconvenience to him, and the difficulty of acquiring suitable premises in the neighbourhood to take the place of that portion of which he is deprived, are little likely to cause much heartburning amongst the members of the Corporation. The taking of a portion of a manufactory may easily render the remainder almost useless. Suitable re-arrangement may be impossible, and the manufacturer may be left with expensive premises which he cannot get rid of, and which no longer allow of the proper conduct of his business. It is true that he may get compensation for this, after much wrangling, but in any case it will hardly be adequate to reimburse him for the loss sustained by disorganisation of his trading arrangements.

The appetite of the Corporation for inaugurating and carrying on large undertakings is not even yet sated. In addition to the 11 tramways to be laid down, and the unlimited number of houses to be put up, the manufacture and sale of flagging and paving, or any material used in the paving of footpaths, is to be also conducted at the ratepayers' expense. There is certainly no half-heartedness about all these proposals. Considered as an instalment of the Corporation's fancies, they leave nothing to be desired, and everything to be feared. No doubt a complete works' department, which shall outvie that of the London County Council in wasteful inefficiency, is in speedy contemplation.

Another provision of the Bill calls for special notice. An attempt is made to get rid of Sub-section (4) of Section 174 (wrongly given as 175 in the Bill) of the Public Health Act, 1875. The obnoxious sub-section provides that, "before any contract of the value or amount of £100 or upwards is entered into by an urban authority, *10 days public notice at the least shall be given*, expressing the nature and purpose thereof, and inviting tenders for the execution of the same; and such authority shall require and take sufficient security for the due performance of the same." Why is this most salutary provision irksome to the Corporation?

We cannot dismiss the West Ham Corporation into the obscurity from which it has so unpleasantly emerged without a reference to the conditions upon which they do invite tenders. In the *South Essex Mail*, in the column next following the "summary" of the proposed Bill, there is a notice "to electrical engineers and others" inviting tenders for certain works. It is necessary under Sub-section (2) of Section 174 of the Act of 1875 that the due performance of a contract to execute works for an urban authority should be secured by a pecuniary penalty. The Corporation have interpreted this sub-section as allowing them to make compliance with any fanciful or sentimental whim which may possess them at the moment a term of the contract, and to secure its observance by the same penalty exacted for a serious breach of the contract. The contractor "will be required to pay *all workmen employed by him in or about the contract such rates of pay, and observe such hours of labour as are embodied in the schedule, which will be part of the contract.* In the event of any breach of such agreement the Council will enforce the penalty clause in its entirety." Impertinence would be a mild term to apply to the clause in italics, and the threat which follows it is an idle one. The sum fixed being a penalty, the Corporation could only recover so much of that sum as would be equal to the loss they had actually sustained by the failure to comply with the clause.

Apparently they are alive to the emptiness of this menace, for the notice inviting the unwary electrical engineer to tender proceeds to set out an even more insolent condition. "A tender will not be accepted unless it is stated by the contractor in the tender, and proved to the satisfaction of the Council, that the contractor *at the date of the tender* pays *to the whole* of his workmen such rates of wages and observes such hours of labour as are recognised by the workmen's trade unions *in the several localities* where his work is done. If after the contract is signed it shall be proved that the said statements of the contractor are contrary to fact the Council shall be entitled to rescind the contract, or at its option to recover from the contractor as *liquidated damages*, and not as a penalty, the sum of £50. Now, even a Corporation cannot alter the nature of things by juggling with names. It is more than likely that the £50, even though described as liquidated damages, will be held to be simply a penalty. If so, and the Corporation desires to recover more than merely nominal damages, it will have to prove that it has sustained actual injury.

If the desire to avoid public invitation of tenders is prompted by reluctance to bring these offensive stipulations to the notice of the ratepayers, some slight justification might be found for it. When all private contractors have been choked off, no doubt the Corporation will go rapidly downhill under the burden of its own works department. Meanwhile, considerable sums are to be spent in promoting this ridiculous Bill; and there is little or no chance of most of its provisions finding favour in the eyes of Parliament. It would be only justice if those responsible for the Bill could be compelled to pay the money thus wasted, out of their own pockets.

LIGHT RAILWAYS.

The following is the complete official list of light railway applications which were lodged with the Light Railway Commissioners in November. Most of these have been already mentioned in the Review recently, but the list is of value as giving the gauge, length, engineer's name, &c.:—

Title.	Promoters.	Engineer.	Mileage.	Motive power.	Gauge.
England.					ft. in.
Aldershot and Farnborough (extension) ...	Power & Traction, Limited	G. Hopkins & Sons ...	½	Electric	3 6
Barnsley and District (extension)	British Electric Traction Company... ...	S. Sellon	½	"	3 6
Blackpool and Garstang	Blackpool and Garstang Electric Light Railway Company	J. J. Myres	16¼	"	4 8½
Blyth and District	British Electric Traction Company... ...	S. Sellon	1½	"	3 6
Brackenhill (extension)	Yorkshire District Light Railway Syndicate	Mammatt & White ...	2	Steam	4 8½
Bridgwater, Stowey, and Stogursey ...	H. P. Bouverie, A. Pearce, and R. A. Read	R. M. Parkinson ...	11	"	4 8½
Cheltenham and District (extension) ...	T. Nevins	T. Nevins	2½	Electric	3 6
Cinque Ports	D. Cook...	D. Cook and J. T. Rossiter	67¾	"	3 6
City of Bath	Bath Corporation	C. R. Fortune and G. F. Metzger	18	Mechanical	4 0
County of Hertford, No. 1	Hertford County Council and the Metropolitan Tramways and Omnibus Company	V. B. D. Cooper ...	5¾	Electric	4 8½
" " No. 2	Ditto Ditto	Ditto	2	"	4 8½
" " No. 3	Ditto Ditto	Ditto	9	"	4 8½
" " No. 4	Ditto Ditto	Ditto	3½	"	4 8½
County of Middlesex, No. 2	Middlesex County Council	H. T. Wakelam	12	"	4 8½
Devon South Hams	H. B. Sneridan and T. W. Barber	T. W. Barber	37½	Steam	4 8½
East and West Yorkshire Union, 1900 ...	East and West Yorkshire Union Railway Company	Mammatt & White ...	1¼	"	4 8½
East Sussex	J. Selmes and J. Neve	H. F. Stephens	7¼	"	4 8½
Gloucester and District	City of Gloucester Tramways Company ...	J. Clifton Robinson ...	8	Electric	3 6
Hayling Island	W. Paynter, H. R. Trigg, and E. Belfield ...	Knowles & Russell ...	4¾	"	4 8½
Kingston, Surbiton, and District	Greenwood & Batley, Limited	A. H. Rowan	4¾	"	4 8½
London County (Archway Road, Highgate)	London County Council	Sir A. Binnie	¼	"	4 8½
London County (Clapham, Wandsworth and Kingston road)	Ditto Ditto	Ditto	5½	"	4 8½
London County (Deptford, Shooter's Hill, and Woolwich)	Ditto Ditto	Ditto	5½	"	4 8½
London County (New Cross, Lewisham, and Eltham)	Ditto Ditto	Ditto	4½	"	4 8½
Long Melford and Hadleigh	Rev. Sir Wm. Hyde Parker, Sir Wm. C. Quilter and others	H. F. Stephens... ...	15	Steam	4 8½
Loughborough and District	Loughborough and District Electric Traction Syndicate	C. H. Gadsby	8¼	Electric	3 6
Lulworth and Osmington	H. W. Blundell, F. Terrell, and W. B Pritchard	E. Cruttwell and R. St. George Moore	13½	Steam	4 8½
Mansfield and District	J. Fell, J. Lewis, and W. J. Kershaw ...	C. H. Gadsby	5¾	Electric	3 6
Mid-Anglian	C. T. Molineux-Montgomerie & B. M. Kilby	Jeyes and Godden ...	39¾	Steam or electric	4 8½
Morley and District	British Electric Traction Company... ...	S. Sellon...	10	Electric	4 8½
New Romney and Hythe	South-Eastern Railway Company & London, Chatham, and Dover Railway Company	A. T. Barry and P. C. Tempest	9¼	Steam	4 8½
Oldham, Ashton-under-Lyne, Hyde and District (extensions)	Oldham, Ashton, and Hyde Electric Tramway Company	S. Sellon	4¼	Electric	4 8½
Peterborough and District (extensions) ...	British Electric Traction Company ...	Ditto	1	"	3 6
Spen Valley (extensions)	Ditto Ditto ...	Ditto	12	"	4 8½
Tickhill...	Wm. McDonnell Mackay and G. H. Newborn	L. B. Wells	17½	Steam	4 8½
Wakefield and District	J. Fell, J. J. Gittings, E. Horton, and W. J. Kershaw	Pritchard & Co.... ...	10	Electric	3 6
Warrington and Northwich	A. Anderson, J. Hesketh, and A. Brown ...	R. H. Scotter	13¼	"	4 8½
West Hartlepool (extensions)	Hartlepool Electric Tramways Company ...	S. Sellon	1¾	"	3 6
Wigan...	Wigan and District Tramways Company ...	Ditto	7¾	"	3 6
Windermere and District	British Electric Traction Company ...	Ditto	6½	"	3 6
Witney, Burford, and Andoversford ...	Witney, Burford, &c., Light Railway Syndicate	Sir J. Szlumper and W. Szlumper	23¾	Steam	4 8½
Wotton-under-Edge	Railway Developments, Limited	A. P. J. Cotterill ...	3¼	"	4 8½
Wales.					
Llanelly and District...	Llanelly and District Electric Lighting Co.	R Wilson	7¼	Electric	3 6

LEGAL.

Jackson v. Clough.

The hearing of this case lasted nearly six days at the recent Leeds Assizes, where it came before Mr. Justice Grantham and a special jury. The plaintiff, Mr. Frederick Sagar Jackson, sued Mr. Walter Owen Clough, M.P., for damages for alleged false and fraudulent misrepresentations, and also in respect of certain alleged untrue statements contained in the prospectus of a company known as the India-Rubber Company (Mexico), Limited, of which the defendant became a director. It was alleged that, owing to certain false statements, the plaintiff had been induced to underwrite debentures in the company. Mr. Scott Fox, Q.C., and Mr. Manistry appeared for the plaintiff, while the defendant was represented by Mr. Tindal Atkinson, Q.C., Mr. A. J. David, and Mr. H. T. Waddy.

According to the pleadings the defendant was interested in two companies, called respectively the Mexican Finance Corporation, Limited, and the India-Rubber (Mexico), Limited. The first-named was a company to acquire a concession which had been obtained from Mexican land-owners of alleged India-rubber estates. It was also alleged that, in order to induce the plaintiff to underwrite debenture stock in the India-Rubber (Mexico), Limited, the defendant, in March, 1897, falsely and fraudulently represented, or caused it to be represented to the plaintiff (1) that the defendant had made no profit whatever on the sale to the Mexican Finance Corporation, Limited, and (2) that the vendors transferred their bargain to the said corporation without profit, and that the defendant had underwritten £5,000 in the India-Rubber (Mexico), Limited. It was further alleged that the plaintiff, on the faith of the said false and fraudulent representations, agreed to underwrite, and did underwrite, £2,000 in debenture stock in the India-Rubber (Mexico) Limited, and had been compelled to pay £1,600 in respect thereof. It was further alleged that a certain prospectus of the India-Rubber (Mexico), Limited, which was issued with the defendant's sanction, contained the following untrue statements:—(*a*) That the company had been formed to acquire and develop two estates in Mexico, known as La Esmeralda and Llano de Juarez, covering, together, about 287,000 English acres, upon which there were 350,000 India-rubber trees available for tapping. This statement was alleged to be untrue, it being alleged that the estates only covered about 56,000 acres, and that very few trees were growing thereon. (*b*) That La Esmeralda was the largest known matured India-rubber plantation. This statement was alleged to be untrue in every particular. The defence was a complete denial of the allegation in the statement of claim, and that the statements in the prospectus were honestly made after full and complete investigation.

The following outline will serve to show the general nature of the case:—In the autumn of 1876 the defendant and other gentlemen subscribed to send out a Mr. Abrahams to inquire into certain estates in Mexico, said to be capable of producing India-rubber in large quantities. Mr. Abrahams reported favourably on the estate known as the Llano de Juarez; but in the course of the case it came to light that Mr. Abrahams was interested in the successful flotation of the company to the extent of £27,000. This was put forward by the plaintiff as showing that his report was unreliable.

Before forming a company to acquire the estates, inquiry was made of the British Consul at Mexico with regard to the Esmeralda. This gentleman replied by detailing the products that could be got from the estates. The syndicate then agreed to pay £34,000 for the Esmeralda and £116,000 for the Llano de Juarez. In order to carry out the undertaking, the defendant with other gentlemen proceeded to form a company known as the Mexican Finance Corporation. This was registered with a capital of £30,000 in 600 shares of £50 each, and the interest of the syndicate in the land was transferred to the corporation under two agreements. The vendors were to receive £10,000 in cash and shares, while the corporation were to take over the bargain of the vendors with all its privileges. The remainder of the shares in the corporation were to be allotted to the underwriters. The prospectus of the India-Rubber (Mexico) Limited, which was then issued showed a share capital of £406,000, comprising ordinary shares and £200,000 7 per cent. first mortgage debentures of £50. The purchase price of the two Mexican estates, which were alleged to be about 287,000 English acres, and to contain upwards of 350,000 India-rubber trees, was fixed at £556,000 by the Mexican Finance Corporation. This was to be paid as to £150,000 in cash, and as to the balance in cash and shares. [The income for 1897 from India-rubber was estimated to be £87,500.] At this stage the plaintiff was introduced by Mr. Lenty, M.P., to the defendant with a view to underwriting some of the debentures in the Rubber Company. Upon hearing that the defendant was himself underwriting to the amount of £5,000, and relying (as he said) upon the statements in the rubber prospectus, Mr. Jackson consented to underwrite £2,000 of shares. The subsequent failure of the public to take up shares, except to the extent of about £80,000, involved the plaintiff in a liability for £1,600, which he had paid.

In support of the allegations made in the statement of claim, a large number of witnesses were called on behalf of the plaintiff. With regard to the first allegation, namely, that the defendant had said he was making no profit, the plaintiff and Mr. Lenty both stated that the prospectus of the Finance Corporation which contained a statement to the effect that the directors were making a profit, had not been laid before them. Mr. Lenty also stated that he had twice been assured by Mr. Clough that he was making no profit. In answer to this, the defendant said that he had told Mr. Lenty in the first instance, that the vendors to the Finance Corporation were making a share profit but not a monetary profit. He also said that he had sent a copy of the prospectus of the Finance Corporation to the plaintiff in the first instance. He denied that he had ever told Mr. Lenty or the plaintiff that he was making no profit.

With regard to the second allegation, namely, that the plaintiff had been induced to underwrite because the defendant had himself underwritten £5,000 of debentures, it was proved that a list of underwriters had been prepared and shown to the plaintiff, upon which the defendant's name appeared. In answer to this the defendant gave evidence to the effect that he always had been ready and willing to underwrite to that extent, but that owing to the great competition among underwriters he had stood on one side.

With regard to the alleged false statements in the prospectus, a number of reports were referred to during the trial dealing with the area of the estate and the number of rubber trees which had been found thereon by the persons who have been sent out to survey it. Soon after the scheme to buy the estate had been mooted, Mr. Clough and his colleagues had sent out Mr. Abrahams to make a report. The defendant stated that he had been quite satisfied with Abrahams' report with regard to the Llano de Juarez, and that he had been corroborated by a pamphlet issued by the Foreign Office. He never had any reason to doubt that the area of both estates was correctly described, namely, Llano de Juarez, 215,000 acres, and La Esmeralda, 72,000 acres. When the estate was handed over there were annexes which would have made up the deficiency in La Esmeralda. As against this the plaintiff relied upon the report of Mr. Ford, according to whom the cultivated portion of La Esmeralda was only 8,500 acres, the remainder being quite uncultivated.

With regard to Abrahams, the defendant admitted that he had been sent out to make his report soon after he was made bankrupt, and that he was interested in the venture to the extent of £27,000. The company were charging nearly £2 per acre for 287,000 acres, although Sir H. Daring had stated in his report that the price of land was only from 3s. to 4s. per acre. The defendant explained the difference by saying that roads, &c., had to be erected on the property.

The learned Judge in the course of his summing up called attention to the Directors' Liability Act of 1890, and to the important issues under Section 3 of that Act which was raised in the case. He left the following questions to the jury:—(1) Were the statements in the prospectus set out in the statement of claim untrue? (2) Did the defendant believe or had he reasonable cause to believe that they were true? (3) Even if the defendant believed that the statements were true, had he reasonable ground to believe that the person who made the report on which the statements in the prospectus were founded was competent to make it? The jury found for the plaintiff on all counts, and assessed the damages at £1,100.

Mr. Tindal Atkinson applied for a stay of execution pending an appeal, which was granted subject to the payment of the full sum into Court within 14 days.

CORRESPONDENCE.

Berrenberg and Tested Lamps.

I have read the correspondence in your paper *re* the "Berrenberg Lamps" and also "Tested Lamps."

Now, I would suggest that the Tested Lamp Company should test the Berrenberg lamps, whether there is gas in their globes or not, whether their filaments are flashed or otherwise.

This would leave you free to attend to your editorial duties, which barely include the testing of lamps.

No doubt, if these lamps were connected to the Metropolitan Electric Supply Company's mains between 4 and 8 p.m., they would show as much light as any others, and have an extremely long life.

I am responsible for a small station in a town which is little better than a village, and I wish my customers were educated up to the London standard.

If the lights give so much as a flicker, I dare not walk through the streets for a week.

X.

The Scarcity of G.P.

In view of the present scarcity and high price of gutta-percha, and as now all attention is devoted to South Africa where, in consequence of the war, there are many unemployed, would it not be worth while for some of our specialists to examine and experiment with the juice of the Euphorbia? There are an immense number of these trees along the coast line and in the thorn valleys of Pondo-Land, Natal, and Zululand, and probably also further north.

There are several sorts of Euphorbia. They resemble cactus in appearance, and when the bark is cut a quantity of white juice like milk or cream exudes.

If this is thrown into boiling water it coagulates and becomes a more or less plastic substance, very much like gutta-percha. This may or may not be of value, but I do not think it has ever been brought to the notice of anyone capable of judging.

Possibly it may have some as yet undiscovered use, and in future form an export from the localities where the trees grow in abundance.

If this letter meets the eye of anyone in Natal who would take the trouble of collecting some and send it, say, to the office of your paper, you could hand it to some firm or expert who would be willing to publish his opinion of the substance in your columns. In fact, I would say of this letter, "Natal newspapers please copy."

J. E. R.

[The plant named has been thoroughly investigated times out of number, by manufacturers and experts.—Eds. Elec. Rev.]

BUSINESS NOTICES, &c.

Books Received.—"Annuaire pour l'an 1900," publie par le Bureau des Longitudes. Paris: Gauthier-Villars. 1fr. 50c.

"Electric Power Transmission" by Louis Bell. Second Edition, New York: *Electrical World and Engineer.*

No. 33. "Fire Tests with Glass." A casement glazed with ¼ inch plate glass. A casement glazed with 32 ounces sheet glass. A casement glazed with "Lead Lights." London: The British Fire Prevention Committee. 1s.

Charge of Fraud.—At Wonford Petty Sessions on 19th inst., Ernest John Thomas, an electrical engineer, of Exeter, was charged with obtaining, by false pretences, copper wire from Heaton and Degard, wire manufacturers, of Birmingham. Prosecutors received a letter with a heading describing the applicant as a consulting electrical engineer, of Plymouth, Tavistock and Exeter, asking for one mile and a quarter of copper wire. It was signed on behalf of J. J. Thomas, after which was placed "C.E." They sent the wire, valued at £3 17s. 6d.—William Edward Weston, goods porter, Tavistock, said defendant signed the book for the wire as "J. J. Thomas, C.E."—Detective Crocke deposed to apprehending the prisoner at Plymouth. He was occupying one room with his wife and children, and there were no appearances of any business having been carried on. Prisoner admitted he had no business books. Witness found that he had not carried on any business at Exeter, Plymouth, or Tavistock. The prisoner told him he had been in business in Exeter between 10 and 12 years as an electrical engineer, and established himself at Plymouth in 1897. Committed to take his trial at the Quarter Sessions.

Electrical Wares Exported.

Week ending Dec 27th, 1898.		Week ending Dec. 26th, 1899.	
Adelaide	Value £500	Albany	Value £15
Alexandria	30	Alexandria	29
„ Teleph. mat. ..	56	Amsterdam	33
Algoa Bay	234	Bombay	66
Amsterdam	40	„ Teleg. wire	80
Bombay	13	Boulogne	30
Buenos Ayres	2,059	Bremen	68
Calcutta	239	Brisbane. Teleg. mat. ..	57
Colombo	60	Brussels	124
Delagoa Bay	44	Buenos Ayres	1,150
Durban	139	„ Teleg. wire ..	634
Hamburg	110	Calcutta	648
Las Palmas	31	Chinde. Teleg. mat. ..	64
Marseilles	18	Christiania. Teleg. wire ..	226
Melbourne	2,246	Colombo. Teleg. mat. ..	278
Penang	107	Copenhagen. Teleg. wire ..	95
Singapore	61	„ Telephones ..	38
St. Petersburg	30	Durban	1,156
Sydney	689	„ Teleg. mat.	79
		Havre	30
		Hong Kong	608
		Launceston. Elec. motor ..	120
		Madras	95
		Malta	27
		Marseilles. Teleg. cable ..	694
		Melbourne	264
		„ Teleg mat.	1,037
		Montreal	96
		Perth	44
		Port Elizabeth.	68
		„ Teleg. cable ..	371
		Shanghai	678
		Stockholm. Teleg. mat. ..	557
		Sydney	886
		„ Electric detonators ..	70
		„ Teleg. mat.	98
		Wellington	763
Total ..	£6,706	Total ..	£11,281

Foreign Goods Transhipped.

Bombay. Elec. goods ..	Value £87
Durban. Teleph. mat.	449
Hong Kong. Elec. light appts.	263
Total	£799

Bankruptcy Proceedings.—The first meeting of creditors and public examination in *re* W. Dalsiell, electrical engineer, Newcastle-on-Tyne, are to be held on December 29th and January 11th respectively at Newcastle.

Mr. H. Crewdson Howard, 17, Coleman Street, E.C., has been appointed trustee in the failure of W. Rowbotham, electrical engineer, Teddington.

The first meeting of the creditors of Henry L. Howard, of "Wyvestow," Dragon Parade, Harrogate, and carrying on business at 16, Stonegate, York, and 17, Carlisle Street, Hull, electrical and mechanical engineer, and trading as Thomson, Howard & Co., was held at the Official Receiver's office, York, on 19th inst. The debtor's statement of affairs showed that the liabilities of 75 unsecured creditors amounted to £1,998 10s. 5d., and the preferential claims to £42 3s. The assets consisted of stock-in-trade £322 10s. and furniture £300, and with other property amounted to £733 2s. 11d. The deficiency was £1,307 11s. 4d. The debtor attributes his failure to losses on contracts and other business losses. The public examination was fixed for January 5th.

At the Bankruptcy Court on 20th inst. there was a sitting for the public examination of J. C. Howell, electrical engineer, before Mr. Registrar Hope. The accounts showed total liabilities £19,120, of which £10,348 was stated to be unsecured, and an estimated surplus in assets of £1,084. It appeared from the Official Receiver's observations that the debtor described himself as an electrical engineer, and that he commenced business on his own account in 1881, without capital, at Llanelly. In 1890 he took offices at 24, Queen Victoria Street, and traded at Llanelly and in London until 1892, when the business was formed into a company (J. C. Howell, Limited), with a nominal capital of £25,000. The debtor stated that he received as vendor £10,000 in fully paid shares, and remained with the company as managing director, at a salary of £800 per annum, until November, 1895, when the company went into voluntary liquidation. Since 1898 the debtor had acted as managing director of J. C. Howell, Limited (No. 2), a company which was formed in December, 1895. The debtor having been examined at some length, his examination was ordered to be concluded.

Liquidations, Dissolutions, &c.—Creditors of Rounds' Accumulator Company must send particulars of their debts, &c., to Mr. A. Pegram, 70 and 71, Bishopsgate Street, E.C., liquidator, by January 26th.

A general meeting of F. H. Royce & Co., Limited, will be held at Manchester on January 30th to hear an account of the winding up from the liquidators.

Bolling & Lowe's Trade Review for 1899.—In concluding their report last year, Messrs. Bolling & Lowe stated that the prospects of the iron and steel trades for 1899 were very encouraging, and this view has been fully justified. These industries have had quite a boom, and the workmen have fully shared in the benefits. The prosperity of 1899 is largely due to abnormal home requirements, and not specially to exports. This is confirmed by the amount of Government orders placed and the great extension of railways, tramways, electrical installations, shipbuilding, &c.; further, it is reported that Parliament has been applied to for powers to sanction the raising of about £95,744,257 for similar purposes. It is remarkable that in each succeeding boom of late the rise has generally been on a more limited scale and of shorter duration, *e.g.*, 1879, 1889. It remains to be seen whether the present advance will be an exception. In this connection it is noticeable that manufacturers often obtain smaller profits on the higher prices than in normal times when wages and raw materials are proportionately lower and the latter often less difficult to obtain. Germany takes the major portion of the orders from Russia and Eastern Europe, the former being at present one of the largest buyers of iron and steel, and likely to remain so for many years. Nevertheless, Germany's exports have decreased this year on account of the enormous home demand. Besides possessing a direct cable to the Bay of Biscay, she contemplates laying another, of home manufacture, to the United States, and this will probably be followed by others to various countries. The fact that the iron and steel mills in the United States are busy with home requirements (the accumulation of several bad years), and that they can spare little of real magnitude for the outer world, keeps prices rising here and on the Continent, but when the time comes for them to seek outlets for their surplus production, the position will probably be reversed. Their gigantic trade combinations have yet to prove their value to the shareholders and the country. To direct concerns working with vast capitals hitherto unheard of in the industrial world, and, in some cases, under totally new conditions, must require master minds. The Indian Government has granted powers for the construction of 550 miles of tramway and road railway, and three of the largest towns, viz., Calcutta, Bombay and Madras, intend converting their tram lines from horse to electric traction. The total mileage of railways in British India at the beginning of this year was 22,491 miles open, and 3,568 under construction. The many great Indian rivers, with falls suitable for electric power installation, will no doubt soon be utilised. The production of rails in Great Britain is likely to amount to 900,000 tons, of which about 600,000 to 700,000 tons are for export, the remainder being for home consumption. Our exports in iron and steel will exceed those of 1898 in quantity and value, in the latter especially, on account of the exceptional rise in prices; this includes a considerable quantity of pig iron, which goes abroad to be worked up, very often to compete in its manufactured state with material produced here. Since the Light Railways Act came into force there is evidence that the idea is very favourably received by the public. They will be the means of opening communication between towns and villages which were formerly too far apart for ordinary cart traffic, and will also be one of the inducements for the establishment of factories in the country, instead of in or close to towns, consequently shifting the working population further out. The metric system is gaining ground all over the world, but the British Empire has not yet adopted it. With this exception buyers mostly employ it for their inquiries and demands. When we are full of work in this country, as at the present time, manufacturers hesitate to take the trouble to transpose the English measures into metric and *vice versâ*. Business often leaves us for that reason in favour of our competitors, and once custom is placed in new channels it is difficult to regain. The practical success gained by Signor Marconi with his wireless telegraphy has undoubtedly been the scientific achievement of the year, and will prove a great commercial benefit. The prospective Pacific cable uniting British Columbia and Australasia is still in embryo, and the new Telephone Act has been too short a time in existence to demonstrate its expected benefits.

Change of Address.—The Western Electric Company notify that they have removed from their offices at 79, Coleman Street, E.C., to Bridge Chambers, 171, Queen Victoria Street, E.C.

The "Economic" Boiler.—For this type of boiler (Davey, Paxman & Co.) which, as will be seen from another column of this issue, is employed at the Waterloo and City Railway works, the attributes of efficiency, economy and durability are claimed. The "Economic" is of an internally fired type. The furnace terminates in a brick combustion chamber, which becomes greatly heated—in fact, to almost a white heat—and the combustion is stated to be perfect. There is an absence of smoke, which enables the surfaces to be kept clean and to absorb the heat, the gases being cut up in a similar way to those passing through the tubes of a locomotive boiler. In addition to this, the gases pass into a smoke box and are directed round the external surface of the boiler. This is a greater advantage, perhaps, than is commonly thought of by casual observers, inasmuch as the boiler is kept at a more uniform temperature, with the result that there is an absence of leakage set up by undue expansion and contraction in the flue, shell, or tubes. The heating surface is of such a character that the distribution of heat has the greatest effect. These boilers have a large capacity at the water level, thus providing a good steam reserve against sudden calls, and giving a good working margin for the feed supply. In proportion to its heating surface the boiler occupies but little space. The tubes are made ¼th of an inch larger at the fire box than at the smoke box end so that they can be easily removed. There is almost entire freedom from smoke in consequence of the excellent combustion. These boilers are capable of standing heavy firing, being worked at high pressures, they are very reliable, and the cost of repairs is said to be almost *nil*. The "Economic" boiler occupying small space (about half of the Lancashire boiler), there is only a small amount of brickwork required, and the boiler is, therefore, cheaply set. The cleaning of smoke tubes and flues, and also the removing of tubes, is entirely effected from the front of the boiler. The new arrangement of smoke tubes, which Davey, Paxman & Co., Limited, have recently patented, enables thorough inspection to be made internally of every part of the boiler. A very large number of "Economic" boilers are in constant work, and so far as their experience goes, the cost of repairs does not average 5*s.* per annum. They are being adopted very largely for general purposes as well as for electric light installations, and their excellent working is giving great satisfaction.

Factory Act Summons.—At the Sheffield Police Court last week Messrs. W. E. Burnard & Co., electrical engineers, of St. Mary's Road, were summoned under the Factory and Work-

shop Acts. The assistant inspector stated that on Saturday, December 9th, the defendants employed two young persons, under the age of 16 years, until a quarter to five in the afternoon, whereas they should have left the premises at four o'clock. A representative of the defendant company said they had forgotten all about the Act. A fine of £2 in each case was imposed.

Electricity in Mining.—The chairman of the Pigg's Peak Development Company in the course of his speech to the shareholders last week, said:—

Working costs are now reduced to under 10s. per ton, and the extraction is considerably better than formerly. Having demonstrated that we have a payable proposition, I should like to tell you what we propose to do when we can resume work. In the first place, we would stop the continued running of the present mill and utilise the electrical power to push on developments in depth until we have a large tonnage of ore opened up for stoping. We should then duplicate the electrical power line from the Falls, where we have almost unlimited water power for all purposes, and erect a new mill and cyanide plant near the entrance to the low level tunnel, where our water supply for mill will be much more permanent and ample than at the old mill site, and facilities for handling the ore more economical. These proposals entail a large expenditure of capital.

The "Financial Times" and the Copper Combine.—The *Financial Times* has latterly been doing a good turn to the electrical engineering industry by devoting some of its surplus energy to an assault upon the American Copper Syndicate, and we hope these articles may be widely read and discussed. In our issue of December 8th we made some reference to these and other articles in our notice of the copper market in November: and below we give an extract from a still stronger article which appeared in the issue of the *Financial Times* for December 19th. This article endorses the opinion which has from time to time found expression in our notes during the past year, that sooner or later the increased supply of copper from outside sources will bring about the collapse of the syndicate's control.

The fall in the prices of American copper stocks during the year has already been extremely heavy, and one of the greatest sufferers is the Amalgamated Copper Company itself. Only a comparatively small amount of the shares was subscribed for by the public, either in Europe or America, and it is estimated that the Standard Oil clique themselves hold no less than $60,000,000 of the $75,000,000 of shares created. It is believed also that their other holdings in the copper mining field total about $40,000,000, so that in all they are carrying some £20,000,000 of stock. This is no joke, even for such a powerful combination, and yet they are not only entirely unable to control the production, but even to maintain the price and to force consumers freely into the market. The American banks are beginning now to throw copper shares upon the market, and it is calculated that one bank alone holds some $30,000,000 of Amalgamated shares. When the crisis which was threatened last week really comes about—and in our opinion it cannot be staved off much longer—one of the first collaterals to be thrown out will be Amalgamated. As the *Boston News Bureau* remarked the other day, the Amalgamated cannot go forward and make more shares of the same kind until the present shares are digested or floated, and when the black cloud of undigested Industrials hanging over Wall Street is spoken of Amalgamated heads the list. Complaints have been made of late on this side that the Amalgamated interests are not supporting the copper market as they should do, but the probabilities are that they are finding the immense task they have undertaken a trifle too big even for their capacity. They have endeavoured unsuccessfully to corner copper, and have sunk millions upon millions in the undertaking. They are now being cornered themselves, and can scarcely escape without heavy loss. They will get no sympathy here, even though, fortunately, very little of the loss will fall upon ourselves. If we have escaped lightly it is, however, not due to any lack of effort on the part of the Combine bosses. They have endeavoured to dump copper on the European consumer at famine prices, and they have sought persistently to unload their inflated shares on the European investor. But we have gained wisdom from past experience, and we can now afford to stand by and watch the downfall of the gigantic house of cards they have built with equanimity.

Railway Rates.—Notice is filed in the *London Gazette* under the Railway and Canal Traffic Act, 1888, stating that:—

Whereas applications have been made to the Board of Trade on behalf of all the railway companies in the United Kingdom to amend the classification of merchandise traffic, and schedules of maximum rates and charges, fixed in pursuance of the above-mentioned Act, by adding to the said classification the following articles, matters, or things, viz.:—

To be included in Class 5.

1. Incandescent mantles.
2. Electrical instruments (such as ammeters, voltmeters, &c.).
3. Electrical instruments for use in connection with telephone exchanges.
4. Automatic time registers.
5. Mutoscopes.

To be included in Class 4.

6. Copper cylinders.

And whereas the Board of Trade have heard the parties in support of and in opposition to the application so far as it related to the articles, matters, or things numbered 2 and 3 respectively, and there being no opposition to the said application so far as it related to the articles, matters, or things numbered 1, 4, 5, and 6, respectively. Now therefore the Board of Trade, in pursuance of the powers in them vested by the provisions of section 24, sub-section (11), of the above-mentioned Act, do hereby determine and order that the classification of merchandise traffic and schedules of maximum rates and charges confirmed by the Acts of Parliament set out in the schedule to this order, be amended in manner following, that is to say, by adding to—

Class 4.

1. Electrical instruments for electric lighting and power.
2. Electrical instruments for telephone purposes.
3. Water heaters, copper.

Class 5.

1. Incandescent mantles.
2. Mutoscopes.

Dated this 14th day of December, 1899.

Courtenay Boyle, *Secretary Board of Trade.*

Raaschou v. Cassell and Another.—This was an action heard in the Queen's Bench Courts before Mr. Justice Kennedy to recover damages for an alleged breach of contract to supply two motor vans. The plaintiff, Mr. Theodor Raaschou, an electrical engineer, of Great Smith Street, Westminster, had intended to commence running express motor vans from Covent Garden, Billingsgate, and Smithfield Markets to the south-western parts of London for the purpose of carrying goods direct to the buyers' establishments. The *Times* report says that, with this view, he entered into a contract with the late Robert Rintoul Symon, who carried on business in Abchurch Lane as the Liquid Fuel Engineering Company. Under this contract Mr. Symon had agreed to supply two steam motor goods vans to be constructed according to certain specifications. It was for damages alleged to have resulted from a breach of this contract that the action was brought. The original defendant was Mr. Symon, but on his death the action was continued against his executors, Ernest Cassell and Martha Ann Symon. The price of the two vans was to be £650 each net, and one-third of the price of each van, or a total of £433, was to be paid on the signing of the contract. This sum was paid, and one of the vans was, after some delay, tried in London on December 14th, 1898. According to the plaintiff, the van failed to fulfil the terms of the specification in not being capable of running 50 miles a day with a load of three tons at the rate of six miles an hour, and by reason of its liability to skid. The plaintiff claimed to recover the sum already paid and also loss of profits by reason of the non-delivery of the two vans in accordance with the terms of contract. The plaintiff also claimed certain small items of expenditure. The defendants denied that the van had failed to fulfil the terms of the specification, and said that as to the skidding, it could only be discovered upon the trial and that it had since been easily remedied. Whilst denying all liability, they brought £500 into Court, and said that this sum was sufficient to satisfy the plaintiff's claim.—Mr. Pickford, Q.C., and Mr. Frank Dodd were for the plaintiff; Mr. English Harrison, Q.C., and Mr. J. Eldon Bankes for the defendants.—Mr. Justice Kennedy, in delivering his considered judgment, said that the result of the trial in London was such as to justify the plaintiff in refusing to accept the van, as he promptly did. The trial showed that the van could not be trusted to run as the maker undertook it should run, so as to be under perfect control, or as he impliedly undertook, with reasonable safety. The case therefore practically resolved itself into a question of damages. In the result his Lordship gave judgment for the plaintiff for £622 11s. 8d. and costs, the plaintiff to have leave to take in part satisfaction the £500 that had been paid into Court.

Trade Announcements.—The Clayton Engineering and Electrical Construction Company, Limited, have acquired the works of Messrs. Pollock & MacNab, Limited, and have removed their office from Clayton to Newton, Hyde, where all communications should now be addressed. The Clayton Company are now in a position to promptly execute orders for engines and dynamos up to 5,000 H.P. Special arrangements have been made for the equipment of generating stations for electric tramways and light railways, and a speciality is being made of electric crane building and installation. In connection with this announcement Messrs. Pollock & MacNab state that they have transferred their engine works and foundry at Newton together with the business of engine builders, pumps and accessories makers, and iron founders to the Clayton Company. Their business of machine tool makers, however, will be continued as usual at new premises acquired by Messrs. Pollock & MacNab, which will be known as Britannia Ironworks, Newton, Hyde, as before, and all communications should be addressed there.

ELECTRIC LIGHTING NOTES.

Audenshaw.—Notice appears in the *London Gazette* to the effect that the District Council proposes to transfer its provisional order to the Manchester Corporation.

Barking.—The Local Government Board has sanctioned a loan of £15,080 for the purpose of carrying out extensions of the electricity works.

Boston.—The Town Council has resolved to apply to the Board of Trade for a provisional order to light the town by electricity.

Bridlington.—The Town Council has decided, on the recommendation of the Electric Lighting Committee, to apply to the Board of Trade for a provisional order for the electric lighting of Bridlington.

Camberwell.—Failing to obtain from the County of London and Brush Provincial Electric Lighting Company, Limited, particulars of the price required to purchase the company's undertaking, the Vestry has resolved to appeal to the Board of Trade for assistance in obtaining the necessary information.

Chester.—The Corporation has decided on the purchase of an additional engine and dynamo, at a cost not exceeding £3,165, to cope with the increasing demand for electricity.

Crowland.—The Local Government Board has refused to grant urban powers to the Crowland District Council to light the town.

Croydon.—Colonel W. Langton-Coke, C.E., held an inquiry, for the Local Government Board, on Thursday, last week, into the application of the Council to borrow £25,000 for the extension of the electric lighting.

Cumbrae Lighthouse.—The electric light is being installed at Cumbrae and will shortly be in operation. The expenditure involved amounts to over £3,000.

Dowlais.—It is stated that the Iron and Steel Company has under consideration the laying down of a large electrical installation to supply both the old and the Ivor works; but so far the scheme is only in embryo. At the old works there have been recent extensions in electric lighting, and they have proved satisfactory.

Egremont.—The District Council has resolved to apply to the Board of Trade for a provisional order for the supply of electricity. In a report by Mr. J. Enwright, the initial cost is estimated at £9,450, with a connection of 2,300 8-c.p. lamps. Although coal is cheap at Egremont, gas costs 4s. 7d. per 1,000 cubic feet; the prospects for electric lighting are, therefore, rosy.

Fladbury.—An ancient water-wheel at the Fladbury Mills has been removed, and in its place are fixed two 40-inch turbines, capable of giving 35 H.P. under the available head of water. The two turbines can be driven either singly or together for the mill work or the electricity alone, as necessity requires. The turbines are of the British Empire make, manufactured by Messrs. Armfield and Co., Ringwood, Hampshire, and the dynamos used are Messrs. B. Young & Co.'s. The bulkhead walls to which the turbines are fixed are 24 inches thick, consisting of blue bricks and cement, with a foundation of concrete 3 feet 6 inches in thickness. The cables are put in all the way up the village to Weston House, and in the course of a few more days light will be supplied from this installation. It is proposed by the small company who have taken this work in hand, which is called the Fladbury Electric Lighting Company, of which Mr. S. H. Deakin is chairman, that storage cells for the present shall be fixed at the respective houses where the light is supplied, in case of very high floods. Only a limited number of houses in the village are supplied at present, but as time goes on there is no reason why, with the extension of machinery, as there is still plenty of waste water-power that could be made available, adjoining villages should not also be supplied from the same source. This work has been contracted for by Messrs. B. Young & Co., electrical engineers, Birmingham, from plans by Mr. A. W. Keen, who has superintended the whole of the work.

Glamorgan.—The Glamorgan County Council last week considered a report by the Parliamentary Committee, which stated that a company had been projected to acquire Parliamentary powers to distribute electric energy in the county, and they sought very extensive powers of carrying electric mains along and across the roads. The Committee recommended the Council to authorise them, or some other committee specially appointed, to obtain expert advice as to the extent to which the powers sought will affect the public interest of the county and the property and rights of the County Council, and how such powers ought to be modified or guarded, and, if thought expedient, to present a petition against the Bill. The Council decided to strengthen the Parliamentary Committee to deal with this particular matter.

Gloucester.—At a meeting of the Gloucester City Council last week the consulting engineer, Mr. R. Hammond, M.I.C.E., and Mr. R. Read (city surveyor), who have visited various cities where destructors are in operation, presented a report as to the best system which could be adopted in connection with the electric light works. They recommended the twin-cell system as erected by Messrs. Heenan & Froude at Farnworth. It consists of two cells side by side, only separated from each other by a low bridge like that at the back of a boiler grate, so that an open communication exists between the two cells. Each cell has a charging door on one side of the furnace corresponding to the clinkering door on the opposite side, and the combustion chamber is placed above the two cells, extending the whole length of them; above the combustion chamber is fixed the boiler. The feeding is done through a hopper, which is provided in connection with each charging door, so that the refuse can be put straight on to the grate bars, and the men on the clinkering side can also pull it forward, if necessary, so that there is a direct course either by pushing from the charging door or pulling from the clinkering door to get the refuse into the grate. The blast is fed to the under side of the ashpit, the grate being supplied with air blast by a fan, or by a steam jet, the whole under entire control. The main feature of the destructor is, that by simply altering the direction of a damper, the gases from either grate can be alternately made to travel over the hot fire in the other grate, and so into the combustion chamber, and finally into the boiler. The whole apparatus is compact and close together, without any long flues for loss of heat before reaching the boiler. Charging and clinkering taking place alternately, first with one cell and then the other, there is always a hot fire in the one cell to cremate the smoke and fumes from the other. The guaranteed consumption is 12½ tons per cell per 24 hours. There are two boilers, with a large heating surface, and guaranteed to evaporate from 1½–2 lbs. of water from and at 212° F. per lb. of refuse. The Council adopted the report, and accepted Messrs. Heenan and Froude's tender for the erection of the destructor, £4,150. This, it was explained, is not the lowest tender, but the Committee deemed it advisable, in order to have a destructor which would combine all the latest improvements, not to allow £500 to stand in their way.

Hebburn.—The District Council has resolved to apply to the Board of Trade for a provisional order for the supply of electricity in the district.

Kensington.—At last week's Vestry meeting some discussion arose over the negotiations which the surveyor was authorised to enter upon with the surveyor appointed by the Kensington and Notting Hill Electric Light Companies as to the price to be paid for the land at Wood Lane, which the companies have acquired from the Vestry. The Vestry's surveyor submitted a letter from the companies' surveyor, Mr. H. A. Hunt, stating that he was authorised to offer £1,600 per acre for the land, and intimating that in the event of the Vestry not seeing their way to accept this price, the matter must go to arbitration, or a jury, as the Vestry might prefer. It was considered by the Vestry that the price offered was inadequate, and it was thought advisable that the matter be submitted to arbitration.

Llandudno.—Notwithstanding the more general use of electricity, the chairman of the Gas Committee reports an increase of nearly 3,000,000 cubic feet in the manufacture of gas this year as compared with last; £11,539 is being spent upon gas extensions.

Marylebone.—In consequence of the repeated failure of the electric supply in the Marylebone district recently, a meeting of residents and tradesmen interested was held on Wednesday night last week at the Portland Hotel, at which it was decided to take common action with a view to obtaining a better supply in future, and compensation for the loss now being sustained.

Ogmore Valley.—The secretary of the Ogmore Valley (Glam.) Electric Light and Power Supply Company has applied to the local District Council for an extension of the company's license for a further year, pending its application for a provisional order. The Council has assented.

Pwllheli.—At a special meeting of the Town Council last week, a resolution to the effect that the Council apply to the Board of Trade for a provisional order for supplying the town with electric light was passed.

St. Helens (I.O.W.).—The District Council has accepted the terms of the electric lighting company, allowing purchase after 14 or 21 years.

St. Pancras.—The Vestry last week considered a letter from Mr. Dewey, clerk to the Islington Vestry, referring to the laying of mains in Brecknock Road and York Road. The letter stated that whilst Islington

> Is anxious to give your Vestry every possible assistance, it regrets that it is unable to accede to the request now made, seeing that it is not legally empowered to assent to your Vestry laying mains in the parish of Islington.
>
> I may add, that its action in connection with the matter coincides with that it has deemed it advisable to take in connection with applications by the National Telephone Company and others, who have applied from time to time for the Vestry's permission to lay mains, &c., under streets in this parish.

In commenting on the letter Dr. Walter Smith, chairman of the Electricity Committee, stated that it showed that their neighbours were not so ready to help them as they had professed a few months ago. With the new boundaries, however, those roads would be in St. Pancras a year hence, when the Vestry would be in a position to supply the consumers. Mr. Barnes suggested that the Committee should take the bull by the horns and at once proceed with the laying of the mains. In his opinion, no action would be taken in regard to the matter, but the suggestion did not seem to meet with approval. As to the condensing plant required for the Regent's Park station, Dr. Smith stated that of the five tenders received one was too high, whilst the other four did not comply with the specification. The Committee had, therefore, decided to advertise for fresh tenders, but the Vestry refused their application for permission to accept a tender, so as to avoid delay in the delivery of the condensing plant.

Sudbury.—The Town Council has decided to apply to the Board of Trade for a provisional order for the supply of electricity.

Whitechapel.—The electricity supply was formally turned on last week. As the generating station is not yet completed, a temporary building has been made use of, so that while the larger building is being erected the Board can be securing a good business. At an informal gathering at the depôt, the electrical engineer, Mr. Arthur Wright, said that the electric light was the light of the poor, and that by the system to be adopted in Whitechapel it would be cheaper than gas. A great mistake had been made in beginning at the West End, for the long hours in which artificial light was used in the East End, and the late hours at which shops closed, rendered the district the most profitable for electricity.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Aberdeen.—Major Sir Francis Marindin, of the Board of Trade, last week inspected the new permanent track of the Corporation electric tramway from Union Sreet to Woodside, a distance of 2½ miles of double track. The line is now open for traffic.

Barking.—At a meeting of the Urban Council last week tenders to the amount of £4,810 were accepted for the electrical portion of the light railway to be constructed between Barking and Beckton. The consideration of tenders for other portions of the plant was deferred.

Liverpool.—The tramway receipts for the fortnight ending December 20th were:—Horse cars and omnibuses, £7,746, a decrease of £3,333 as compared with 1898; electric cars, £5,020, an increase of £3,917, the net increase thus being £583. The passengers carried were—By horse vehicles, 1,374,996, a decrease of 123,578; by electric cars, 1,054,911, an increase of 838,875, the net increase being 715,297. The mileage was—Horse vehicles, 217,711, a decrease of 16,458; electric cars, 97,861, an increase of 82,453, the net increased mileage being 65,995.

(*Continued on page* 1053.)

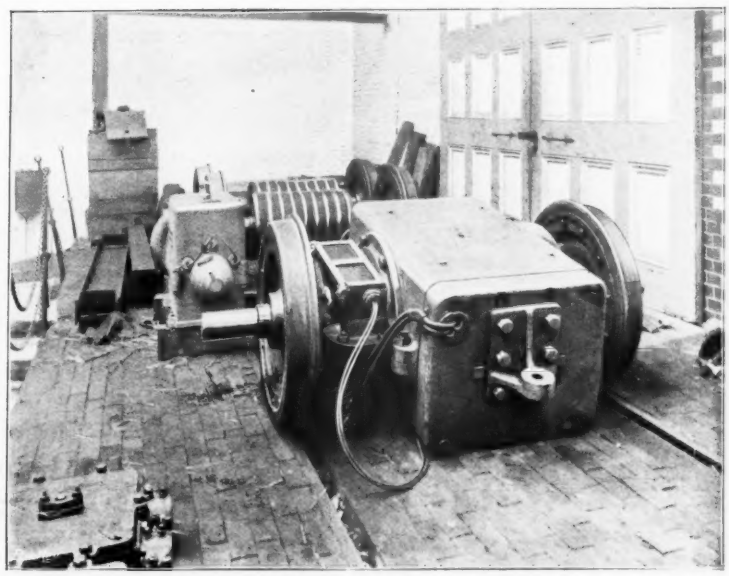
THE WATERLOO AND CITY ELECTRIC RAILWAY.

Since the Waterloo and City underground line commenced working in July, 1898, we have, at intervals, given certain details regarding the undertaking. For general notes of the system we may refer our readers to an article in the Electrical Review for July 15th, 1898, and to the authorised abstracts of papers read at the Institution of Civil Engineers a few weeks ago by Messrs. H. H. Dalrymple Hay and B. M. Jenkin.* The details and photographic views of the generators at the works at Waterloo were given in our issue of June 16th, 1899, p. 980.

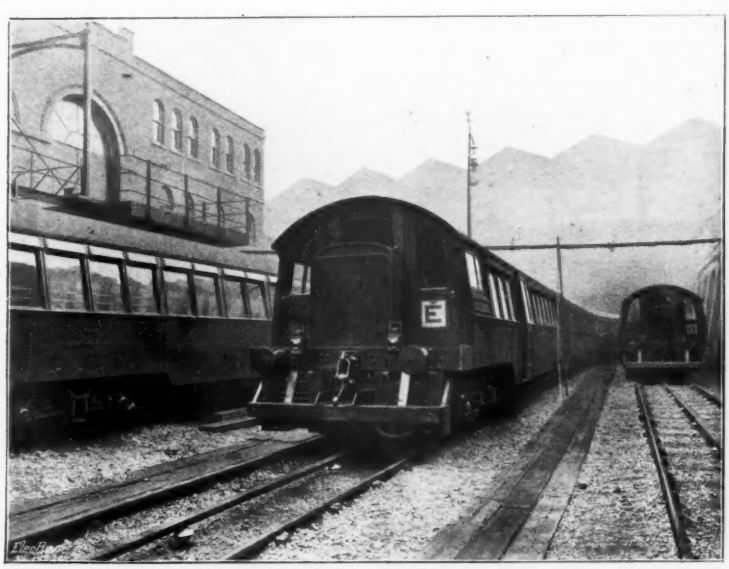
By the kindness of the contractors and of Mr. Jenkin, who has favoured us with the loan of a number of the lantern slides used to illustrate his Civil Engineers' paper, we are enabled to supplement the information already given.

The steam-raising plant which is shown in one of the photographs consists of five Paxman "Economic" steam boilers, each fitted with a Vicars' patent mechanical stoker, with suitable engine, with shafting and pulleys for working the same.

The boilers are 14 feet long × 8 feet diameter, and each is fitted with two flues (2 feet 8 inches diameter), and provided with two circulating tubes. There are 92 smoke tubes of 3 inches external diameter. The heating surface is about 1,180 square feet, working pressure 160 lbs. per square inch; hydraulic test 260 lbs. per square inch. Each boiler will evaporate 7,500 lbs. of water per hour. Each flue is provided with Paxman's patent expansion boiler flue, the form of which gives it such strength, that thinner plates can be used in the construction than it would be safe to use in the plain flue. This is a great advantage, as it is a well-known fact that the heat passes more rapidly through thin plates, which are thus rendered more durable, because they do not become overheated. In this way the full excellence of the materials is retained for a great length of time. The strength and durability of a boiler depend greatly on there being proper provision for expansion and contraction. When this is not provided for, furrowing and ripped seams are the inevitable results. Paxman's patent expansion boiler flue provides completely for this, without injuring its efficiency as a stay. The flue is made up of a series of short lengths, which are made of fine, soft, and exceedingly tough steel. The plates are bent in such a way as to be when finished perfectly cylindrical, thus adding to the strength of the flue. They are then carefull welded, after which the ends are heated in a suitable furnace and enlarged in a powerful flanging machine in such a way that the end of one plate fits exactly within that of the next; the holes are then drilled through both and riveting completes the work. Both the laps, or doubling of the plates at the seams, as well as the rivet heads are removed from the line of draught and consequently escape the scouring action and intense heat of the gases as they pass along the flue. Flues made on this principle have withstood severe tests most successfully, and the collapsing strength is almost doubled.



Motor and Axle Removed from Bogie.



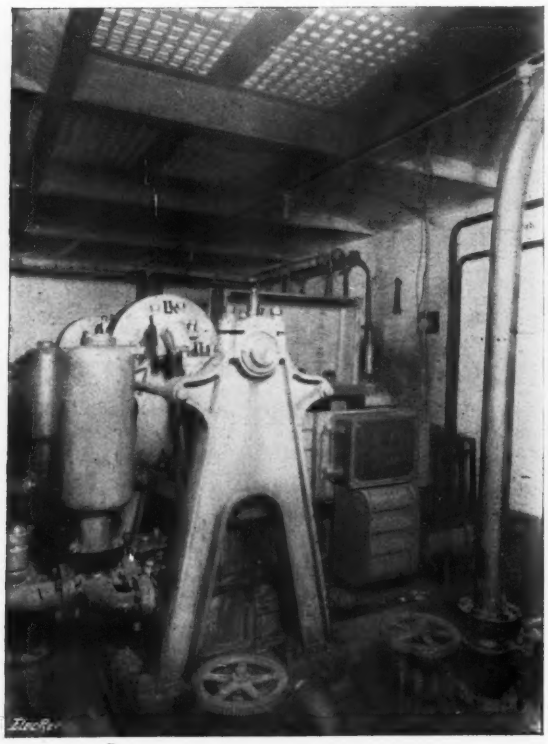
Electric Trains in Sidings at Waterloo.

The generators, of which particulars have already been given, consist of six Belliss T.E.C.4 high speed, vertical engines direct coupled to two-pole direct current generator

* Electrical Review, November 24th, 1899, p. 859.

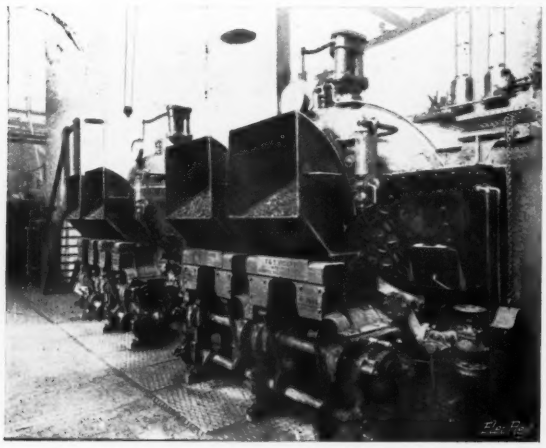
of Siemens's well-known type, each provided with a fly-wheel weighing about 6 tons.

The engines govern excellently, the momentary variation in speed being less than 4 per cent. when the full load is



Pump Room.

suddenly taken off, and under 2 per cent. when the full load of 380 amperes is switched on after the set has been running light; the permanent increase of speed from full load to no load is only 0·8 per cent. The efficiency E.H.P./I.H.P. of



"Economic" Boilers and Vicars' Stokers.

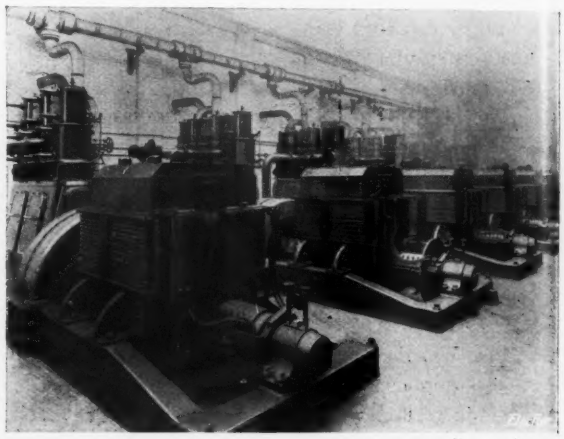
the combined sets at full load is 86 7 per cent., and at half load 81·7 per cent.

The train service is, as our readers are well aware, conducted almost entirely through twin tunnels, one for the "up" and one for the "down" service. The length from Waterloo Station to the City station, situated at the end of Cheapside and Queen Victoria Street, is 1½ miles.

In regard to the line construction, the steel conductor rail, which is of channel section, weighs 39 lbs. per yard, and has a specific electrical resistance equal to eight times that of copper. It is carried on porcelain insulators, which are mounted on iron stalks screwed to the sleepers.

Fig. 1 shows the special type of support used for anchoring the rail, the insulators in this case being surmounted by a malleable iron cap, to which the rail is secured by a bolt to prevent creeping.

The insulated conductor rail is placed between the two running rails of the permanent way. It is laid in 30 feet lengths, these being connected by copper bonds of 1·5 square inch section (see fig. 2), the bond serving



Six Belliss-Siemens Railway Generators.

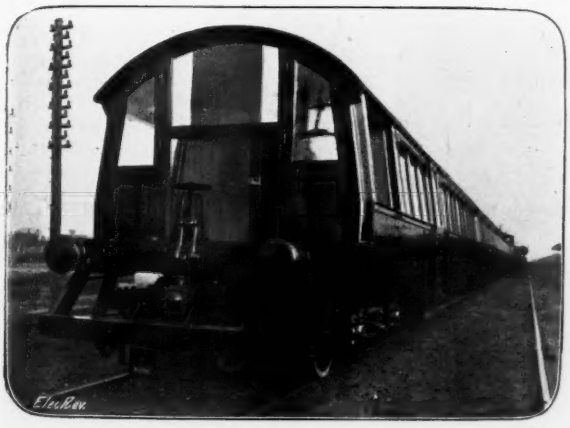
the double purpose of fishplate and electrical connector. The copper rivets by which the bonds are attached to the channel steel are expanded into the rivet holes under hydraulic pressure, so that the electrical resistance between the surfaces in contact is negligible.

Interior of Trailer.

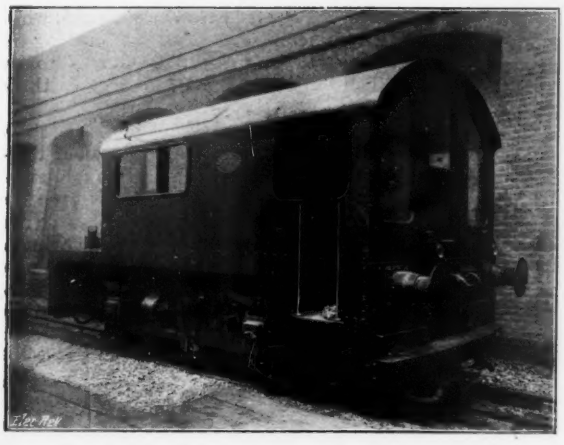
The running rails, which are used as the return path of the current, are bonded with copper bars of 1 square inch section, which lie outside the fishplates, and are connected

with the rails by coned copper rivets in a manner similar to the bonding of the conductor steel (fig. 3).

The feeders and central conductor for the "up" and "down" lines are independent of each other, and accidents



End View of Motor Car before being Electrically Equipped.

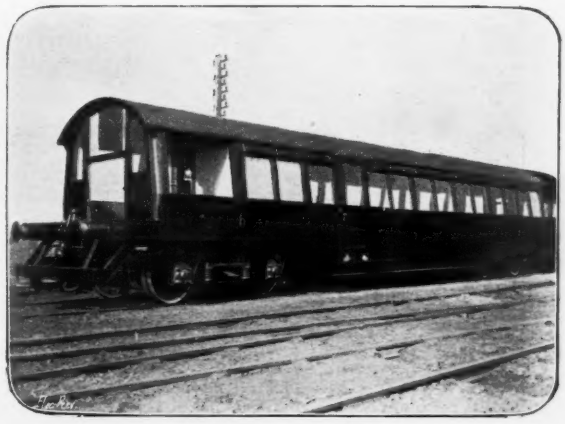


Shunting Locomotive.

Front View of Motor Car showing Cab, Controller and Resistances.

occurring on one line or tunnel do not affect the supply of current to the other. The tunnel lighting is effected by an independent system of feeders and mains while the train-lighting is managed from the circuit supplying power to the motors, the track rails being used for the return. A motor carriage is at each end of the train with two trailers between them. The former have collector shoes. There are two 4-wheeled bogies to each carriage, and on one bogie of each motor carriage there are two Siemens's series wound motors. The motor armatures were built directly on the driving wheel axles, the field magnets surrounding them being fixed in position, so that they move in a horizontal plane with the bogie, but cannot rotate. No reduction gearing is employed.

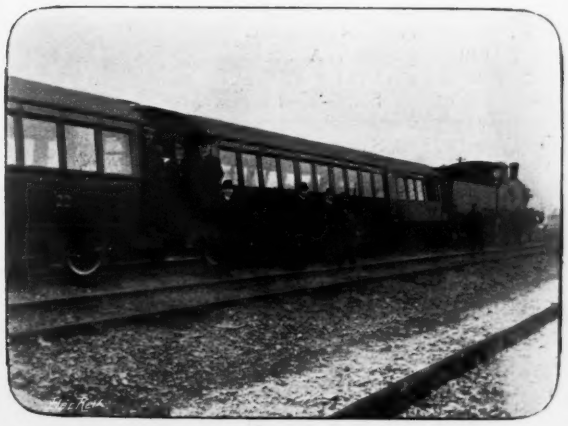
Each motor carriage has its driver's cab, of which we



Motor Car before being Electrically Equipped.

show the interior in fig. 4. Here there are fitted up a Siemens series-parallel controller, brake regulators, an automatic cut-out for 600 amperes, and gauges for indicating the current, voltage, air pressure, and speed of the train. The height of the interior of the cab is rather less than that of the passenger coaches, the floor being raised 16 inches to give room for the motor on the bogie below.

The controllers and motors at each end of the train are



Motor Car and Trailer on South-Western Main Line.

connected by rubber-insulated cables laid along the roofs of the cars. In fig. 5 we illustrate the coupling used for connecting these cables. It will be noticed that it has 13 distinct sets of contacts, separated from one another by "stabilit" insulators. The two halves of the coupling are bolted together, and pressure is put on the interlacing contact pieces by tightening the screws at the ends of the coupling.

One of our photographic views shows a motor bogie with two motors and collector shoe on the front end. When the photograph was taken the car was jacked up to allow

for the removal of the bogie. We also illustrate the motor and axle as seen removed from the bogie, spare armatures on axles being shown in the rear. Other views show the front of a motor car with the cab, controller, and resistances; and a motor car without electrical equipment as it was brought up on the South-Western main line. In another illustration the motor armature may be seen on axle, but the magnets were not at the time in position. A motor car and part of a trailer on the main line of the South-Western Railway appear in another view, being drawn by a South-Western locomotive.

Motor Bogie showing Motors and Collector Shoe.

Messrs. Siemens Bros. & Co. were the contractors for the entire electrical equipment of the Waterloo and City line. Mr. D. Heap is the resident electrical engineer at the generating station.

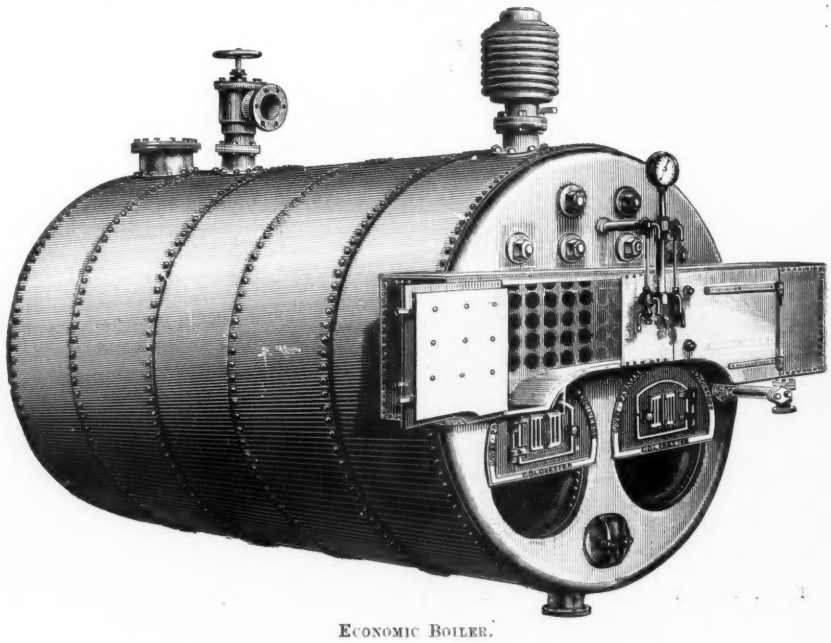
ON THE VALUE OF A HORSE-POWER.

By ED. C. DE SEGUNDO,
Assoc.M.Inst.C.E.

The above is the title of a paper presented at one of the meetings of the American Society of Mechanical Engineers. The author, Mr. George J. Rockwood, was much struck by the entire absence of anything like a consensus of opinion on the value of a horse-power amongst the experts called to give evidence in a lawsuit brought by the owners of certain water-power concessions against the municipal authorities of the town of Worcester, Mass., who had diverted a portion of the river upon which these concessions were granted, for the purposes of the water supply to the town.

The quantity of water diverted amounted to an average, throughout the year, of about 5,500,000 gallons in 24 hours. There were 80 water privileges controlled by 67 owners, the total head of water being 827 feet. The hydraulic engineers on both sides seemed to be fairly unanimous as to the quantity of power lost, which was put at 1,000 H.P. for 11 months in the year, but the legal minds were not so readily prepared to accept this estimate, and the matter was further complicated by the fact that the loss of power to the various owners ranged from 66 H.P. to a fraction of 1 H.P. The case was tried before a commission consisting of a lawyer of experience in water cases, a manufacturer and user of water-power, and a hydraulic engineer, and after a trial extending over 50 days, in the course of which a very large number of witnesses on each side were examined, a verdict was given for the plaintiffs for $500,000 with interest at 6 per cent. per annum. Unfortunately, the wording of the verdict of the commission gives no useful reasons for their decision, and, what is even more disappointing, nothing is said as to how the $500,000 is to be divided between the 67 owners of these privileges.

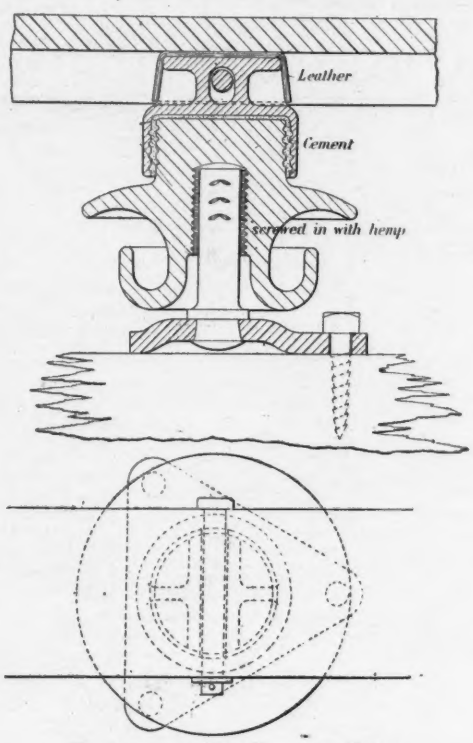
The arguments advanced by the plaintiffs and the defendants are ingenious and interesting. It was held by the plaintiffs that "a horse-power is a piece of property—a commodity—which may be considered as on the market, and hence as having a definite market value known to those who deal in it." The financial injury done to the plaintiffs was therefore easily arrived at—according to *their* view—by ascertaining the market value of 1 H.P.* and multiplying it by the number of horse-power of which they had been deprived by the action of the city authorities. Counsel for the defendants argued in reply that, in point of fact, the owners had not been



Economic Boiler.

* Although a horse-power is spoken of throughout the paper, what is clearly intended is a horse-power-year.

deprived of any "horse-powers," but that by the diversion of a certain quantity of water, the owners had lost an easement or privilege attaching to their estate, namely, the right to make use of such water as might flow through their premises without unduly affecting the flow to others below them — in other words, that the river did not produce "horse-power," which could be taken away and sold at the nearest market like vegetables. Hence, argued counsel for the defence, there can be no such thing as the market value of a "horse-power." Moreover, in this case the "horse-power" resulted from the utilisation

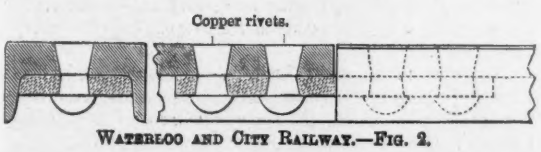


Waterloo and City Railway.—Fig. 1.

of falling water, which varied in volume to such an extent that every mill on the river possessed steam plant capable of supplying nearly the whole power required.

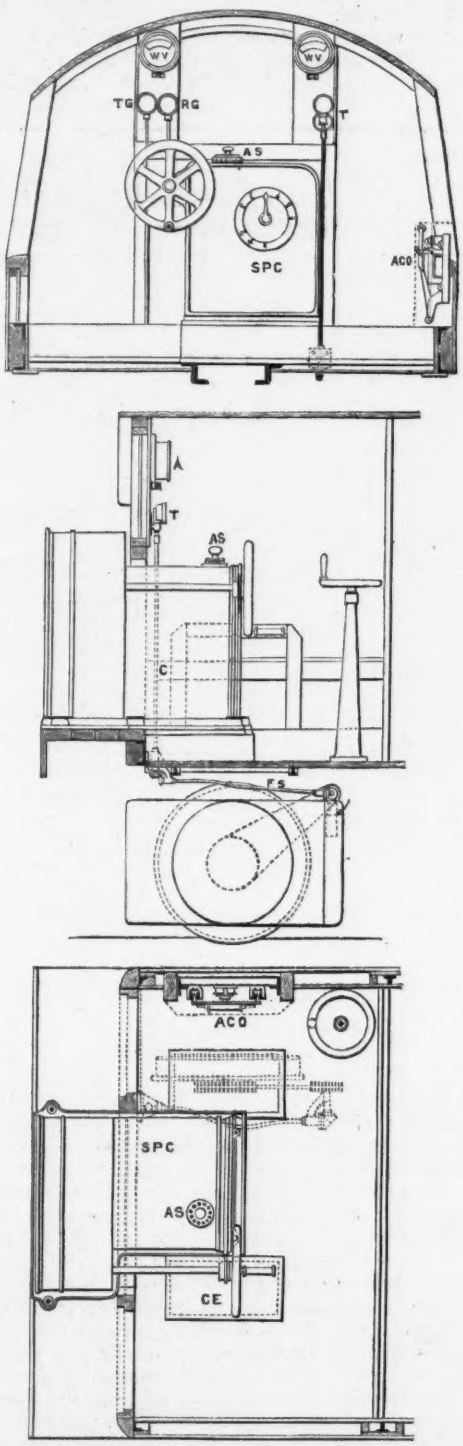
Another point upon which the opinions of the experts on both sides were diametrically opposed was whether the damage sustained by the diminution of 1 H.P. in a water-power was to be valued at the cost of production of 1 H.P. or at the price which could be obtained for it, say, by way of rental. In the absence of any precedent as to which view should be taken, it is obvious that neither side would ever convince the other on this point.

It is, of course, never possible to arrive at the an easement by a mathematical formula, and everyone who has



Waterloo and City Railway.—Fig. 2.

had experience of valuations of any kind will readily admit that, except in cases to which well known precedents apply, a valuation becomes a matter of opinion. The author of the paper under discussion deplores that this should be the case. After calling attention to the names of those called as expert witnesses, he says "undoubtedly at this very moment each side still considers the other to be most obviously in the wrong. This, of course, is highly unsatisfactory from an engineering point of view, though, perhaps, not unusual considered from the legal standpoint." With deference to the author, however, is this innuendo justifiable? Could any result other than a complete disagreement between the experts on each side have been anticipated in the circumstances? In the first place, the flow of water varied to such an extent that, admittedly, each mill was fitted with steam power capable of driving the whole plant, and it was further testified that at times there was no flow at all. It would thus be impossible to fix upon any proper proportion that the amount diverted should bear to the total flow, and at such



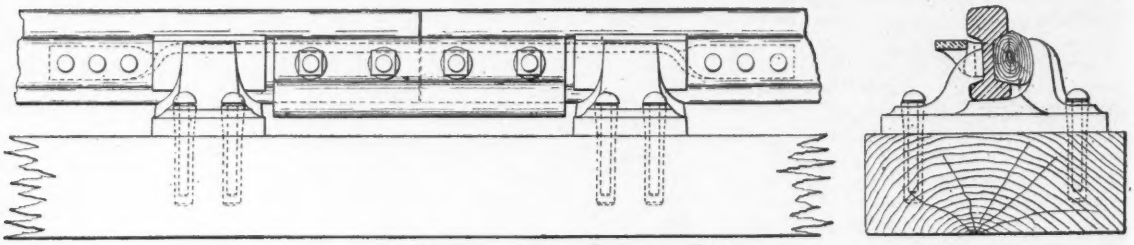
W V, Weston voltmeter and ammeter; T G, Train gauge; R G, Reservoir gauge; T, Tachometer; A S, Ammeter switch; S P C, Series parallel controller; A C O, automatic cut-out; A, Ammeter; F S, Flexible shaft; C E, Commutator end.

Waterloo and City Railway.—Fig. 4.

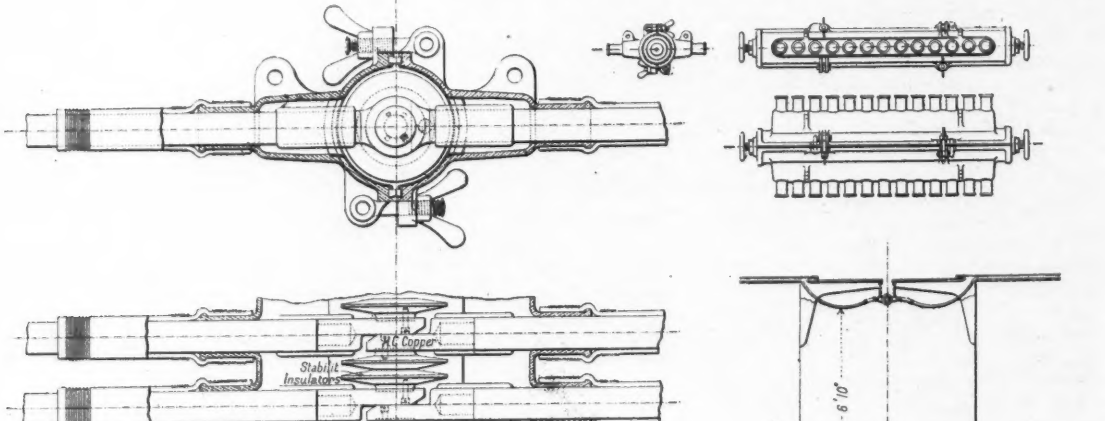
times as the river was practically dry, the diversion would also be *nil*. Further, the loss of power to individual owners was stated to vary from 66 H P. to a fraction of 1 H P., and the pecuniary damage sustained would be dependent upon the proportion that this loss bore to the total power obtained before the city authorities diverted a portion of the water.

The same volume of water must flow through each privilege* at any one period, and the power which can be obtained from it will vary directly as the head. Thus the man who drives his turbine under a 50-foot head, will suffer five times (roughly) the loss in horse-power that would be sustained by a millowner at another privilege where only 10-feet head was available. This point does not appear to have been considered in the trial.

Without wishing in any way to cast aspersions upon the sincerity of the expert testimony given, it must not be overlooked that the millowners had suffered a loss, and were



Waterloo and City Railway.—Fig. 3.



Waterloo and City Railway.—Fig. 5.

anxious to get compensation on the highest possible scale, whereas the city authorities had taken the water, which occasioned the loss, not for purposes of manufacture, or for profit, but for the purposes of the town water supply, and thus had no direct incentive to unduly underestimate the loss sustained by the millowners. We must confess that we sympathise with the argument of counsel for the city, who stated that, in his opinion, the proper way to value the loss was by a computation of the cost of substituting other practical and economical means of generating power at each privilege to the extent to which the normal power at any time was diminished by the action of the city authorities, and as each mill possessed steam power capable of providing for the whole plant, the cost of substituting the power lost would be the cost of the extra coal burnt, plus an allowance for oil, waste and water, and wear and tear and depreciation. This, however, the millowners would not allow, their argument being that the *selling value* of the power lost, and *not* the cost of replacing it, should be the proper test of the damage sustained. This argument was sustained by counsel for the millowners by an illustration which certainly appears to have had the effect of confusing all the experts for the city. Thus:—

Counsel for plaintiffs to witness for defendants:—"If a man's property is taken away from him, don't he get what it is fairly worth and what he can sell it for in the market? A man has got 100 horses here in Worcester. Somebody comes along and takes away 50 of them. He is liable to him for doing it. Now the horses, we will assume, are worth $100 a piece in Worcester in the market. Ought he to have $100 a piece for those horses, or $50 a piece because he has got a ranch somewhere in the West where he can produce them and get them to Worcester for $50?"

To this no satisfactory answer was ever forthcoming. We admit that one seldom thinks of the right thing to say at the right time, but no doubt it has since occurred to the confused witnesses that they were made victims of a forensic trick, inasmuch as "horse-powers" cannot be produced on a ranch out West and taken in some convenient form to market. What the millowners really lost by the diversion of the water was the means of producing power in one particular way at one particular spot, and this is in no sense synonymous with the nature of the loss suggested in counsel's illustration.

Doubtless much could be said on both sides, but in our humble judgment the test of the damage sustained would be the cost of establishing the *status quo ante* or its equivalent. Clearly if the diversion of the water were stopped, the millowners would again enter into the enjoyment of their full rights. This end would, however, also be attained if the means of bringing up the diminished power to its former amount were supplied to the millowners. In this particular case, every mill was obliged to have ample steam-power owing to the varying flow of water, hence the value of the loss sustained could be measured by the cost of a suitable supply of coal, each individual case being considered on its own merits with due regard to the head of water.

In England the valuation of water-powers does not often engage the attention of engineers, but it is a subject of much importance, as the utilisation of water-power for manufacturing purposes of all kinds is rapidly growing, and as it usually happens that waterfalls only exist in the most out of

* The point of diversion being higher up the river than any of the mills in question.

the way places, it almost follows as a corollary that a town will spring up in the neighbourhood, the authorities of which will one day begin to consider the water in the light of a Naboth's vineyard.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

(*Continued from page* 1046.)

Electric Railways in Germany.—A scheme has been prepared, says a financial daily, for the construction of a system of underground electric railways in Berlin. The project, which has already been approved by the Mayor and the Traffic Committee, will shortly be submitted to the municipal authorities, who will be asked to approve the carrying out of the works. It is proposed to construct two circle railways and two transverse lines from north to south and east to west respectively. The scheme provides for the building of the railways by private enterprise at the expense of the town, but whether they would be leased to a company or worked by the city authorities is a question for the future to determine. It is believed that the railways could be completed and opened to traffic in two years from the time of commencement, as was the case with the underground electric railway in Buda-Pesth.

Elland.—On 19th inst. a deputation from the Halifax Corporation waited upon the Electric Lighting Committee of the Elland District Council to discuss the terms on which they were prepared to extend their service of electric tramways to Elland. The question at issue between the two authorities is as to the supply of electric current for the tramways. The members of the Elland Council, who are seeking provisional orders for electric lighting, demand that they shall be allowed to supply the current, and thus provide a day load for their proposed electrical installation. To this Halifax raises the objection that it would entail divided control of their tramway system, to which they decidedly object, but they are prepared to erect a sub-station near Elland, and from this supply not only the current for the tramway, but electricity for lighting purposes as well. They threaten, if Elland refuses to accept their terms, to drop their scheme of going to Brighouse by Elland, and to content themselves with a line to Brighouse *viâ* Hipperholme. After a prolonged discussion last week no definite decision was arrived at.

Hastings.—The Council will oppose the Cinque Ports light railway scheme but will dissent only to that part of the scheme inside the borough.

Hull.—A horse took fright at an electric car in Hessle Road one night last week. It was knocked down, and its rider fell beneath the car and was killed.

Italy.—The Government has approved of the scheme to adopt electric traction on the railway between Milan and Varese.

Liverpool.—A Walton electric car collided with a lorry on 19th inst., overturning the wagon and injuring the horses.

Manchester and Liverpool.—The Bill for incorporating and conferring powers upon the Manchester and Liverpool Electric Express Railway has been deposited for next session, in accordance with the Standing Orders of Parliament. By this Bill the incorporated company ask for powers to construct a railway 34 miles 4 furlongs 2 chains in length, commencing on the west side of Deansgate, Manchester, passing from thence *viâ* Salford, Pendleton, Eccles, Widnes, Halewood, Garston, and Toxteth Park to its termination in Liverpool, near the entrance gate of the Bluecoat Hospital in School Lane. The capital required for the construction of this railway is £2,000,000, which will be divided into 200,000 shares of £10 each, with the right to raise a further £660,000 for equipment purposes by the issue of debenture stock. The first directors of the proposed company will be the Hon. Robert John Strutt, Mr. John Simeon Bergheim, Mr. Edward Tootal Broadhurst, Mr. James Hyslop Macmillan, Mr. William Mather, "and two other persons to be nominated by them or the majority of them." The railway is proposed to be worked by electrical power from a generating station to be erected on a site in the parish of Great Sankey, and the line will be constructed on the monorail system. The time required within which to construct the railway is five years from the passing of the Act, and during this period it is proposed to expend £150,000 in the payment of interest out of capital. The maximum passenger fares proposed to be charged are 2d. per mile first-class and 1d. per mile second-class, with a minimum charge "as for three miles."

South Staffordshire.—With reference to the report of the South Staffordshire Tramways Company's meeting which appeared in our last issue, we are informed that Messrs. Burstall & Monkhouse did not value the Walsall plant, &c., at £18,500. They were not asked to value the line. They were asked to consider a large number of agreements, view the position generally, and advise the board. This they did, and advised the board that the price mentioned was in view of all the circumstances *reasonable*. No car or power house is included in the agreement, and the sale is more an act of policy than anything else, and but for the lease mentioned in the agreement, the board would not have asked the shareholders to accept it. Some of the remarks quoted were not made by the chairman, but were read by him to the meeting from Messrs. Burstall & Monkhouse's report. In our recent list of electric tramways we stated that the South Staffordshire tramway line is leased to the South Staffordshire Tramway Lessee Company. It should be mentioned, however, that the lease is not to begin till February 1st.

Withington.—The Urban District Council on 16th inst. passed a resolution approving of the promotion by the Council in the next session of Parliament of a Bill for constructing additional tramways in the district to be worked by either animal or mechanical (including electric) power.

TELEGRAPH AND TELEPHONE NOTES.

Foreign Press Telegrams.—It is announced that on and after January 1st next press telegrams will be accepted for transmission between the United Kingdom, on the one hand, and France (including Corsica), Algeria, and Tunis, on the other, between the hours of 6 p.m. and 9 a.m., at half the rates for ordinary telegrams, with a minimum charge of 10d. per telegram. The general condition, will be furnished on application to the Secretary, General Post Offices London, E.C.

Huddersfield Telephones.—Last week the Electricity Committee of Huddersfield recommended the Town Council to establish a municipal telephone service, subject to the subscribers having the same facilities as subscribers of the National Telephone Company's system. The recommendation was adopted.

Party Line Telephone Rates.—Taking a hint from the penny-in-the-slot idea, the National Telephone Company are introducing in some towns experimentally what are known as party line rates—a system which has been tried in the States with most excellent results. This system enables each user to send messages for 1d. each, which is collected at the time by means of an ingenious automatic box, thus doing away with all monthly or quarterly accounts. This great cheapening of telephone rates is effected by the same wire being used by two or more subscribers, instead of one exclusively as heretofore, and it is then called a two-party, four-party, or eight-party line, as the case may be. The only additional cost to the subscriber is that 10s. per month is charged for a two-party line, 7s. 6d. for a four-party wire, and 5s. per month for an eight-party arrangement. For those who are likely to make but few calls on the telephone this new departure offers very obvious advantages, and this concession on the part of the National Telephone Company must greatly increase the use of the telephone all over the country.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
West Indies:—		
Jamaica-Colon	June 30, 1899 ...	...
Trinidad-Demerara (1871 original)	Oct. 20, 1899	Nov. 9, 1899.
Do. do. (1891 duplicate)	Oct. 6, 1899	one cable restored.
South African:—		
Zanzibar-Mombasa	Oct. 27, 1899 ...	...
Mozambique-Lourenço-Marques	Dec. 18, 1899 ...	...
Cayenne-Pinheiro	Oct. 11, 1899 ...	...
Latakia-Cyprus	June 20, 1899 ...	...
Landlines.		
West Indies:—		
Communication with Les Cayes (Haiti)	Nov. 22, 1899 ...	...
South African:—		
Communication with Mafeking...	Oct. 13, 1899 ...	...
Communication with all offices beyond Orange River	Oct. 18, 1899 ...	...
Communication with Burghersdorp, Cape of Good Hope, and Estcourt, Natal...	Nov. 7, 1899 ...	...
Communication with north of Mooi River (Natal)	Oct. 22, 1899 ...	...
Colombian Government lines to Bogota	Oct. 21, 1899 ...	...
Communication with interior of Colombia, excepting Amalfi, Ambalema, Buga, Cartago, Ibagua, Manizales, Medellin, Palmire, Pasto, Popoyans, Reimedos, Sonson, and Santo Domingo... ...	Nov. 6, 1899 ...	...
Communication with Valentia (Venezuela)	Nov. 18, 1899 ...	...
Indo-European lines between Odessa and Kertsch	Dec. 20, 1899 ...	Dec. 21, 1899
Saigon-Bangkok	Dec. 16, 1899 ...	Dec. 23, 1899

Telephone Service.—At the meeting of the St. Luke (Middlesex) Vestry last week, a letter was read from the London County Council stating that their attention had been called to the fact that the National Telephone Company had lately carried out works in several parts of the metropolis without first having obtained their consent, as required by the Telegraph Acts, to open the roads. For a considerable time the Council had been endeavouring to come to an arrangement with the company, but the negotiations had hitherto proved abortive. They asked to be immediately informed when the company commenced any works in the district. Mr. W. Howes, chairman of the Vestry, said that the Telephone Company had the sanction of the Vestry under an agreement to open the roads. What

the company had done in St. Luke up to the present, they had done openly and above board. In view, however, of the letters received from the Postmaster-General and the County Council, they should give them no further permission to lay pipes in that district. After some discussion, the officers of the Vestry were directed to inform the County Council when the company commenced works.

Wireless Telegraphy.—A Central News telegram from New York says:—"The United States Navy Department, after exhaustive experiments, has decided not to employ the Marconi system of wireless telegraphy in the American Navy. The Department officials believe they can themselves perfect a system equally good, if not better."

CONTRACTS OPEN AND CLOSED.

OPEN.

Accrington.—January 10th. The Town Hall Committee invites tenders for the switchboards, wiring and other works and appliances necessary for the electric light installation in the Town Hall. For specification and to view the various rooms, apply to the Borough Surveyor, Town Hall.

Barking.—January 23rd. The Urban District Council wants tenders for two continuous current transformers and switchgear, underground cables and roadworks for the Creeksmouth electric lighting extension. See "Official Notices" to-day.

Barnes.—January 9th. The Urban District Council is inviting tenders for the supply and erection of:—(Section A) boilers; (B) steam dynamos and switchboard; (C) storage batteries; (D) cables, &c. Only those firms with plant of a similar size and type working satisfactorily in other electricity works will be allowed to tender. Specifications, &c., of the Surveyor, Council Offices, High Street, Mortlake, on deposit of £1 1s. for each section. Plans, specifications, &c., may be inspected at the offices of the engineer, Mr. William Fairley, 53, Victoria Street, S.W.

Bermondsey.—January 13th. The Vestry wants tenders for the construction, &c., of a dust destructor, with furnaces, water-tube boilers, economiser, fans and forced draught appliances, in connection with the electricity supply undertaking. See "Official Notices" December 15th.

Birkenhead.—January 16th. The Corporation is inviting tenders for the construction of a new electricity generating station in connection with the electric tramways.

Dublin.—January 1st. The Dublin United Tramways Company is inviting tenders for the supply of general stores, including car fittings, iron, steel castings, oils, paints, glass, brushes, ironmongery, harness materials, electrical supplies, coal, &c., for the year ending December 31st, 1900. Particulars at the company's offices 9, Upper Sackville Street.

Hackney.—January 2nd, 1900. The Vestry wants tenders for the supply of accumulators. See "Official Notices" December 1st.

Ilford.—January 20th. The District Council wants tenders for water-tube boilers, economiser, pumps, pipe work, two 200-kw. and one 100-kw. dynamos, motor boosters, battery, switchboard, 15-ton traveller, mains and road work, arc lamps and posts, and station lighting. See "Official Notices" December 15th.

Manchester.—December 30th. The Tramways Committee wants tenders for 450 electric tramcar bodies. See "Official Notices" December 15th.

Melbourne.—March 1st. The Corporation is wanting tenders for boilers, engines, dynamos, switchboard, feeders, mains, arc light leads, accumulators, &c., for electric lighting. See "Official Notices" December 22nd.

Mistretta (Sicily).—December 31st. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Palermo, stating that tenders are invited by the Municipality of Mistretta, not later than December 31st next, for the establishment of a service of electric lighting in that town. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m.

Newcastle-on-Tyne.—January 24th. The Corporation wants tenders for laying down about 11 miles of double line tramway, the rails, fastenings, and the poles being supplied by the Corporation. See "Official Notices" December 22nd.

Port Alegre.—December 31st. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Minister at Rio, stating that tenders are invited by the municipality of Porto Alegre, not later than December 31st next, at 1 p.m., for the electric lighting of that town.

Salford.—January 8th. The School Board invites tenders for the electric lighting of the new schools in Grecian Street North, Lower Broughton. See "Official Notices" December 22nd.

Spain.—January 16th. Tenders are being invited until January 16th by the municipal authorities of Utrera for the concession for the electric lighting of the town by means of 300 10-c.p. lamps and 100 16-c.p. lamps. Tenders to be sent to El Secretario del Ayuntamiento de Utrera (Spain) whence particulars may be obtained.

Tunbridge Wells.—January 15th. The Corporation invites tenders for condensing plant to deal with 30,000 lbs. of steam per hour. See "Official Notices" December 22nd.

Tynemouth.—Tenders are wanted for free wiring of premises in connection with the Corporation electricity works. See "Official Notices" to-day.

CLOSED.

Cork.—The Committee of Management have placed the contract for the electric lighting of the Lunatic Asylum with Messrs. Handley & Shanks, of Cork.

Gloucester.—The City Council have accepted the tender of Messrs. Heenan & Froude for the erection of a refuse destructor at a cost of £4,150. For further particulars, see our "Lighting Notes."

Germany.—Contracts have been placed with Messrs. Brown, Boveri & Co., of Baden and Switzerland, and Messrs. Siemens and Halske, of Berlin, for the conversion of the horse tramways in the town of Mannheim into electrical lines.

Glasgow.—Yesterday's *Daily Telegraph* is responsible for the following:—"The Glasgow Corporation has accepted the offer of the National Conduit Cable Company, New York, for electric feeders for the city tramways. The American price was £151,000, or £10,000 under the lowest British offer."

Lambeth.—With reference to the tenders given below for the supply of 25 arc lamp-posts and lamps for public street lighting purposes, Mr. F. A. Nixon, in a report to the Vestry on the subject, states that the offers from the best known firms very closely correspond in price and vary roughly from £700 to £850. The tenders were numbered by the chairman of the Vestry in the order in which they were opened, and not in that which appears in the complete list given. In this connection Mr. Nixon says:—

Nos. 1 and 7 are not complete and need not be considered. Nos. 3, 11 and 8 are very high-priced, and are not from the most well-known firms. No. 9 is a tender for a type of lamp which is, so far as I know, quite new and cannot be recommended from any extended experience. The remainder, arranged according to the price of the tender and which will bear closer inspection, are as follows:—No. 4, Messrs. Gilbert & Co., £868; No. 6, Messrs. The Brockie-Pell Company, £854 7s. 6d.; No. 12, Messrs. Johnson & Phillips, £822 10s.; No. 10, Messrs. The General Electric Company, £788; No. 2, Messrs. Oliver and Co., £784 12s.; No. 5, Messrs. Crompton & Co., £697. The difference in the price of these six is chiefly attributable to the price of the arc lamp itself, and as this is the most important consideration, especially in view of the position in which these lamps are to be placed, I think the Committee will not be content with accepting other than the best. The arc lamps specified in the tenders Nos. 5 and 10 have not in my experience given satisfaction on the South London Company's circuit, and I could not recommend their adoption. I am not acquainted with Messrs. Oliver & Co.'s arc lamp, and so of the remaining three, I unhesitatingly advise the acceptance of Messrs. The Brockie-Pell Company's tender, in which is included the Brockie-Pell L type lamp, which is one of the best in the market, and which has been giving great satisfaction where it has been installed on the South London Company's mains.

	£	s.	d.
Crompton & Co.	697	0	0
Johnson & Phillips	711	0	0
Oliver & Co.	784	12	0
General Electric Company	788	0	0
Johnson & Phillips	822	10	0
Brockie-Pell Arc Lamp Company (accepted)	854	7	6
Gilbert Arc Lamp Company	858	0	0
S. Griffith (Davy Lamp)	862	0	0
S. Griffith (Johnson & Phillips Lamp)	987	10	0
British Blahnik Arc Light Corporation	1,020	0	0
Thomas Kershaw	1,350	0	0
W. J. Allen & Co. (incomplete)	—		
W. S. Vellinghausen ,,	—		

The explanation of two tenders being received from one firm is that separate departments submitted independent offers.

Maidstone.—The Corporation contract for storage batteries at £1,390 has been given to the Chloride Electrical Storage Syndicate.

FORTHCOMING EVENTS.

Thursday, January 4th—At 8 p.m. At 20, Hanover Square. Röntgen Society. Paper by Chisholm Williams, Esq., F.R.C.S., on "The Interpretation of Skiagrams." Future arrangements of this Society are:—February 1st. Dr. Hugh Walsham—"Röntgen Rays in Diseases of the Chest." March 1st. Mr. J. H. Gardner — Subject to be announced later. April 5th. Dr. Norris Wolfenden and Dr. Forbes Ross—"The Influence of the X Rays upon the Growth and Development of Micro-organisms.

Tuesday, January 9th.—At 8 p.m. The Institution of Civil Engineers Papers:—"The Purification of Water after its use in Manufactories," by Reginald A. Tatton, M.Inst.C.E.; "Experiments on the Purification of Waste Water from Factories," by W. O. E. Meade-King, M Inst C.E.

Friday, January 12th.—At 8 p.m. Institution of Civil Engineers. Students' meeting. Address by Prof. T. Claxton Fidler, M.Inst.C.E., on "The Theory of Structures and Strength of Materials."

NOTES.

1900.—We shake hands with the Old Year with feelings of reluctance, for he has been a good friend to one and all in the electrical profession. But we welcome the New Year with its bright promises of still better things in store. May the year 1900 see a greater degree of electrical development at home and abroad than any of its predecessors. A happy and prosperous new year to all our readers and friends!

Properties of Steel.—We have received copies of two papers on the properties of steel, read at the December meeting of the American Society of Mechanical Engineers. One, by Messrs. Maunsel White and F. W. Taylor, proposes a scheme of nomenclature for the colours of steel during gradual heating from the cool state, with the corresponding temperatures. The scheme is as follows:—

Dark blood red, black red	990° F.
Dark red, blood red, low red	1,050° F.
Dark cherry red	1,175° F.
Medium cherry red...	1,250° F.
Cherry, full red	1,375° F.
Light cherry, bright cherry, scaling heat,* light red ...	1,550° F.
Salmon, orange, free scaling heat	1,650° F.
Light salmon, light orange	1,725° F.
Yellow	1,825° F.
Light yellow	1,975° F.
White	2,200° F.

* Heat at which scale forms and adheres, *i.e.*, does not fall away from the piece when allowed to cool in air. An interesting point of this carefully-prepared scheme is its evidence of the capacity of the eye for judging temperature especially in the neighbourhood of the critical point. This temperature, which varies somewhat with different kinds of steel, is about 1,375° F., and near this temperature the eye seems to be sensitive to about 150° F. The colour at this point is always described by tool smiths by the name cherry red, used by the authors of the paper. No doubt 150° F. is near enough for most purposes, but trained tool smiths must have learned to work much closer than this, and it is certainly not good enough for magnets. Mme. Curie observed that a magnet should be heated but little above its critical temperature; probably more than 35° F. above the critical point is undesirable, and to judge this is evidently beyond the power of the eye. A pyrometer of some kind is a necessity in magnet work.

The second paper, by Mr. W. J. Keep, gives an account of deflections within the elastic limits produced by steady pressure and by blows on spring-tempered steel bars freely supported at their ends. We do not know what the practical application of the results may be, nor is there any indication in the paper, but the experiments were very numerous, very consistent, and very carefully made. In view of the large amount of attention the whole subject of iron and steel is now receiving, the experiments are of considerable interest.

Fatal Accident at Bolton.—On Friday afternoon last a serious accident occurred in connection with the Bolton electricity supply undertaking. We are officially informed that the accident, which terminated fatally, was quite the fault of the two unfortunate men who were killed. They had gone down into one of the sub-stations to remove a transformer which was working in parallel with another. They cut off the supply of current on the high-pressure sides of both transformers by means of high-pressure switches fixed in the sub-station. They then disconnected the low-pressure leads between the transformer to be removed and the switch-board, in order that they might run no risk by the current being transformed up from 200 volts to 2,000. This they did all right: it was in their next move that the accident occurred. After the one transformer was thoroughly isolated, they disconnected both the high and low-pressure cables of the transformer itself, and instead of sealing them up left them hanging loose with the bare ends of the cables touching the metal cover of the transformer, from which the earth wire had already been disconnected in order that the transformer could be lifted out of the sub-station. After they had done this, they proceeded to put on current again to the one which had not been removed, and in doing so, turned on the wrong switch, making the whole of the metal case of the disconnected transformer alive. As it happened, the two men had hold of it and received a shock which ended fatally. We understand that both were capable men, especially one, who was the foreman in charge of all transformers and cables and of outside work generally. Their loss will be very greatly felt by the Bolton Corporation. It seems that the men should not have been working in the sub-station at the time, and they did so altogether on their own responsibility. Furthermore, they never warned the station that they were there, or asked for the current to be cut off. The names of these men are F. Walker, foreman, who leaves a widow and five children, and W. Hazelton, cable jointer, who leaves a widow and two children.

At the inquest on Tuesday evidence was given by Mr. Ellis, the borough electrical engineer, Dr. Adams, and a jointer who was working with deceased at the time. Dr. Adams deposed that Walker was first got out of the chamber and animation was restored, but efforts failed in the case of Hazelton. Dr. Robinson and Dr. Panton arrived, and attempts were made in the Wheat Sheaf Hotel, to which the men had been carried, to restore consciousness, and Walker was afterwards removed to the Infirmary. He examined Hazelton after death, and found that he was burned about the feet and hands, the boots being very much charred. Death was due to electrical shock, and the smoke was caused by the burning. The jointer, named Symonds, said that, being anxious to get the current on as soon as possible, they were doing two jobs at once, hence the mistake. The jury returned a verdict of "Accidental death."

Personal.—Mr. C. P. Sparks, the chief engineer to the County of London and Brush Provincial Electric Lighting Company, Limited, has been appointed consulting engineer to the Bournemouth and Poole Electricity Supply Company, Limited.

Transport says that Mr. Granville C. Cuningham, M.I.C.E., managing director to the City of Birmingham Tramways Company, has been appointed general manager of the Central London Electric Railway, and has already entered upon his new duties.

Herapath's Railway Journal says that Mr. H. Wynne, signal superintendent of the Highland Railway, has been appointed chief signal and electrical engineer on the New Zealand Government Railways.

The German Emperor has conferred the Royal Order of the Prussian Crown of the second class upon Sir Henry C. Fischer, who recently retired from the Post Office Telegraph service.

Middlesex County Council and Electrical Schemes.—The Middlesex County Council has resolved to oppose the following applications for powers:—The application of the Enfield District Council for an electric lighting order, as the main roads and bridges are affected. The application of the Harrow District Council for an electric lighting order. The Heston Boleworth District Council's application for an electric lighting order. The application of certain promoters for an electric lighting order for Teddington. The Twickenham Electric Lighting Order. The application for an electric lighting order for Staines, Egham, and Chertsey, in the Counties of Middlesex and Surrey. The Uxbridge and District Electricity Supply Order. The application for a provisional order by the North Metropolitan Electric Power Company for powers to generate and supply electricity in the areas of the Edmonton and Hendon Unions.

Electric Locomotives.—A lecture has just been delivered at Berlin on "Modern Electric Locomotives," by Herr Tischbein, engineer on the staff of the General Electricity Company in Berlin. The lecturer closed by comparing the economies of steam with electrical locomotives, which were greatly in favour of the latter. Only one man was required to drive the electrical locomotive, and there was, besides, no need for the building of water stations, pumps, ashpits, and water tanks. Electrical locomotion was more economical, in that it worked more continuously than steam locomotion.

Société des Electriciens, Paris.—At the last monthly sitting of the Société des Electriciens, M. Gosselin read a paper on arc lamps working three in series at 110 volts. He described successively the Hegner, Vigreux, and Brillié arc lamps. The first-mentioned works with a shunt resistance which intervenes at the moment that it is required; the others work without any resistance. M. Gosselin worked the systems of lamps, and asked whether there was any gain of light in working three lamps in series. He explained that the diminution in the difference of potential at the terminals of the arc enables the diameter of the carbon to be diminished, and consequently the light to be increased by a certain quantity. He then worked a small alternating current arc lamp, which burned at a difference of potential of 40 volts, with a choking coil in circuit. This lamp is branched on the secondary circuit of a small transformer, placed in the pedestal of the candelabrum that holds the lamp. M. Aliamet advanced certain objections to the working of arc lamps in series without resistance. The resistance is necessary for good working, and has an appreciable influence on the regularity of the light. The arc should have a constant length, and in order to obtain this effect, we must consent to a loss of energy in the line. Without a resistance, during the period of lighting up, the current is very great, and the carbons are brought to a very high temperature, and they often flame. Without resistance the stability of the arcs is not ensured. For three arcs in series the difference of potential is 35 volts at the terminals of each arc. The arc is then short, and the shadows are considerable. Lastly, M. Sartiaux remarked that lamps above 25 amperes could not be used three in series, whereas at the present day lamps of 50 amperes are greatly in request for lighting large spaces. M. Hegner then observed that a special carbon with a particular core is necessary for arc lamps three in series. Also differential arc lamps are required. The rest of the discussion was postponed until the next sitting. M. Lauriol then spoke of the production of electricity by the combustion of household refuse; but he made only vague statements, based on uncertain experimental results.

The Committee on Copper Conductors.—A correspondent writes:—"I notice an article in one of your contemporaries which criticises the report of the Copper Conductor Committee on the ground that three leading cable manufacturers, the N.T.C., and the cable companies were not consulted. As to the report itself, it seems to want a lot of explanation. Resolution 6 seems to be like saying that a man's income shall be calculated from the money he receives. There is no other conceivable way of determining the resistance of a cable than from the dimensions of its strands. The object appears to be to agree upon a set of terms for use in specifying the conductors of cables, so as to make tenders readily comparable, but to an outsider the result seems to be extraordinarily clumsy. Still, unless one has had experience in tendering for cables, one has no right to criticise the methods other people may find convenient. It looks very much as if this is an attempt to defeat fraudulent specifications. We have heard of the carrying capacity of a cable defined by its sectional area, so that the effect of the outer strands lying obliquely is to make the conductivity appear greater instead of less than if they all lay parallel to the axis. I daresay there may be other ways of making the worse cause appear the better."

Mixed Systems.—Mr. A. T. Cooper, engineer to the Reading Electric Supply Company, Limited, writes to us with reference to the article on "Mixed Systems" appearing in the last issue of the ELECTRICAL REVIEW, stating that this has led several of his friends and many of our readers to suppose that Mr. Robert Hammond is consulting engineer to the Reading Company, and as such is responsible for the successful introduction of direct current supply into their home area, which was previously fed on the single-phase alternating system. He points out, however, that this is not the case. We believe that the credit is really due to Mr. Cooper himself. Mr. Hammond was, of course, perfectly justified in mentioning in his report to Sheffield the success of the change advised and carried out by Mr. Cooper at Reading.

The Cast Weld Steel Joint.—The Milwaukee Railjoint and Welding Company has recently designed a new type of its cast weld steel rail joints for the work which it is now doing for the Rochester (New York) Railway Company. The Milwaukee Railjoint and Welding Company is the pioneer in this type of welding. Its success, says the *Street Railway Review*, in welding exposed rails has been such as to excite surprise on the part of railroad men, who had not supposed it was possible to accomplish the results obtained. In 1898 the company welded eight miles of exposed rails between the city of Milwaukee and South Milwaukee. This track has been in constant use ever since, and subjected to the heaviest kind of interurban traffic. The breakage during the winter of 1898 did not amount to 1 per cent. Since the joints were repaired in the spring there had not, up to October 5th, been any further breaks, nor is it expected there will be; neither is there any kinking of the rails. In certain portions of the road slip joints were installed, but in other sections equally long the welding was made continuous, regardless of slip joints. The officers of the company state: "We find by experience that after the track is once adjusted after welding, it does not move a great deal, and there is not much necessity for a slip joint." The track referred to is certainly in first class condition, and will bear the closest inspection. As a result of the manner in which this welding stood the test of extreme temperatures the company received a second contract, for welding 15 miles of suburban track between Milwaukee and Wauwatosa on exposed rails. Another notable contract is on a line of railway running through the main street of Milwaukee, which is believed to be the finest piece of street railway work and cast-welding in the country. This is laid with 72-lb. T-rails on a 6-inch concrete foundation, with concrete between the ties; over this is asphalt paving. It is impossible in riding over this track to discern where the joints occur. The company has recently arranged with the Calumet, of Chicago, for the latter company to do its own welding, using the steel jackets under license; similar agreements have been made with the Rochester Railway Company, and a road at Columbus, O. The contract now being carried out at Milwaukee with the Milwaukee Electric Railway and Light Company, is for 20,000 joints, which, with the work done last year, will make a total of 28,000 joints of the cast weld steel process on that road. The headquarters of the Milwaukee Railjoint and Welding Company are in the Pabst Building, Milwaukee.

Lectures.—Under the auspices of the Greenock Association of Practical Science last week, Mr. M. Blackwood delivered a demonstrative lecture on the practical uses of electrical apparatus and X rays.

Last week, before the Royal Dublin Society, Prof. Barrett, F.R.S., read a paper prepared by himself and Messrs. W. Brown, B.Sc., and R. A. Hadfield, M.I.C.E., on "Further Results of the Determination of the Magnetic Properties of a Series of New Alloys of Iron (Part III.); (*a*) Non-Magnetic Steels; (*b*) Steels of Higher Permeability and not less Hysteresis Loss than the Best Iron." Dr. Molloy followed with a paper on a new method of making Hertzian experiments by which the phenomena of the reflection, refraction, and polarisation of electric waves may be shown to a large audience.

Before the Scottish Section of the Society of Chemical Industry at Glasgow last week, papers were read on the cyanide process of gold extraction, the analysis of copper, the separation of bismuth from lead, and the oxidation of ammonia by iron ore.

Bournemouth Telephones.—The Council having received communications from the Association of Municipal Corporations and Mr. A. R. Bennett, as to whether the establishment of a municipal telephone exchange is contemplated, has resolved to make inquiries of Tunbridge Wells and Southport as to the action taken there in the matter.

Wireless Telegraphy and the War.—A Reuter dispatch from Modder River says that Captain Kennedy, in charge of the wireless telegraphy department, has arrived there, having made most successful experiments between Orange River and De Aar, a distance of over 70 miles.

Crystal Palace Engineering School.—The award of certificates for the Winter Session, 1900, took place on Thursday, December 21st, when Mr. William Tregarthen Douglas, M.Inst.C.E., M.I.Mech.E., M.Inst.E.E., late consulting engineer to Trinity House, presided, and addressed the students. He expressed satisfaction and pleasure in inspecting the work of the students, and gave some excellent advice as to the way in which the school training should be used as a foundation for future progress in the profession.

London County Council Electric Tramways and Light Railways.—The following will give our readers a correct idea of the proposals for which powers are being sought by the London County Council, for which Prof. Kennedy is consulting engineer. All the lines will be 4 feet 8½ inches gauge:—

LIGHT RAILWAYS.		
Deptford, Shooter's Hill and Woolwich.	Double track.	These lines will be equipped on the central conduit system.
New Cross, Lewisham and Eltham.	" "	
Clapham, Wandsworth and Kingston Road.	Part double track, part single track, with loops.	Partly conduit and partly surface contact or overhead.
Archway Road, Highgate ..	Double track.	Overhead equipment.
TRAMWAYS.		
Vauxhall and Camberwell	Double track.	Equipped on central conduit system.
Westminster and Tooting	" "	Partly conduit and partly surface contact.
Blackfriars and Kennington Park.	" "	Equipped on central conduit system.

Presentation.—On the occasion of his marriage, the staff of the Taunton Corporation electricity works have presented Mr. E. B. Thornhill, borough electrical engineer, with a handsome French onyx and ormulu striking clock.

Appointments Vacant.—The Bolton Corporation wants a foreman cable jointer, and a cable jointer. See "Official Notices" this week.

Volunteering for Service Abroad.—The Bristol sanitary authority has resolved to reinstate on their return any of its electric lighting employés who volunteer for foreign service.

Cable Communication with South Africa.—Yesterday's *Standard* says that the Telegraph Construction and Maintenance Company will not be in a position to despatch the completing section of the third cable connecting Great Britain with South Africa until towards the end of January. The section is to be laid between St. Vincent and Ascension, and the task of paying out the cable will probably occupy twelve days. At the earliest this third alternative cable route to the Cape will not be in operation before the middle of February. Meantime the Government have considered the possibility of both the present cables breaking down, and they have stationed a fast cruiser at Ascension, so that in such an emergency messages can be taken from that island to Sierra Leone, and then despatched by the ordinary route to England; in the event of the West Coast cable being broken north of Sierra Leone, whilst the East Coast route was also down, messages would be taken direct from Ascension to St. Vincent. This would mean a delay of at least four days even to Government despatches.

NEW COMPANIES REGISTERED.

Harry South & Co., Limited (64,525).—This company was registered on December 15th, with a capital of £10,000 in £1 shares, to acquire the business carried on at 10—12, Garrick Street, W.C., as "Harry South," and to carry on the business of electricians, electrical engineers, suppliers of electricity for the purposes of light, heat, motive power, and otherwise, and manufacturers of electrical and other apparatus and machinery. The first subscribers (each with one share) are:—M. J. Tilney, 8, Astwood Road, South Kensington, electrical engineer; H. E. Winter, Bush Lane House, E.C., solicitor; J. J. Tustin, 17, Harvist Road, Holloway, N., clerk; T. W. Hale, 6, Ferncliff Road, N., clerk; H. South, 10—12, Garrick Street, W.C., engineer; M. Harley, 33, Southampton Street, Strand, W.C., clerk; and C. H. Bolton, 47, Scarsdale Villas, Kensington, W., clerk. The number of directors is not to be less than two nor more than five; the first are H. South and M. J. E. Tilney (managing directors with £5 each per week); qualification, £1,000.

Sahlstroms, Limited (64,474).—This company was registered on December 12th, with a capital of £25,000 in £1 shares, to manufacture, produce, prepare for market, and deal in ozone and all electrodes and apparatus (whether electrical or otherwise) in relation thereto, and to carry on the business of chemists, druggists, chemical manufacturers, engineers, founders, &c. The first subscribers (each with one share) are:—J. Westaway, 47, Clipstone Street, Portland Road, engineer; J. E. Harris, Monmouth House, Stoke Newington, N., engineer; E. E. Strong, 36, Nunhead Lane, S.E., writer; C. G. Embleton, 26, Carlton Grove, Peckham, S.E., book-keeper; W. L. Williams, 41, Crewdson Road, Brixton Road, S.W., book-keeper; R. S. Darlasson, 162, Grovenor Terrace, S.E., clerk; and W. H. Nex, 10, Fetter Lane, E.C., clerk. The number of directors is not to be less than three nor more than seven; the first are to be appointed by the subscribers; qualification, £100; remuneration not less than £50 nor more than £500 each per annum.

Cecil Wray & Co., Limited (64,480).—This company was registered on December 12th, with a capital of £5,000 in £1 shares, to acquire and take over as a going concern the business carried on by Cecil Wray, at 76, Manchester Road, at 1A, Hallfield Arcade, and Borough Mills, all in Bradford, Yorks, and to carry on the business of metal workers, engineers, camera, cinematograph, lantern, and automatic, mechanical, optical, electrical, and scientific machine and apparatus manufacturers, &c. The first subscribers (each with one share) are:—Cecil Wray, 1A, Hallfield Road, Bradford, Yorks, electrician and optician; Walter C. Atkinson, 18, Park Row, Leeds, chartered accountant; William A. Thornton, Belper House, Wetherby, gentleman; Charles Atkinson, 10, Park Row, Leeds, solicitor; Wilhelm K. Ferro, West Burn, Burnley-in-Wharfedale, manager; George Crowther, 18, Park Row, Leeds, chartered accountant; and Moses Atkinson, Fairmount, Headingley, Leeds, gentleman. The number of directors is not to be less than three nor more than five; the first are William A. Thornton, Charles Atkinson, and Cecil Wray; qualification, £250; remuneration as fixed by the company.

Metal Electro-Amalgamating Syndicate, Limited (64,487).—This company was registered on December 13th, with a capital of £20,000 in £1 shares, to acquire the invention of F. H. Snyder for coating metals by an electrical process, and to carry on the business of metallurgists, makers and workers of alloys, electroplaters, electricians, chemists, chemical manufacturers, &c. The first subscribers (each with one share) are:—H. Firmin, 31, Lombard Street, E.C., merchant; J. E. Bennett, 167, Kingsland Road, N.E., engineer; H. M. Johnson, 3, Westcombe Rise, Blackheath, Commander R.N.; J. H. Hall, 31, Lombard Street, E.C., merchant; J. I. Vivian, 24, Bonham Road, Brixton, S.W., Lieutenant R.N. (retired); J. H. Matthews, 19, Chelsham Road, Clapham, S.W., clerk; and J. Morley, "Loriner Lodge," Sydney Road, Friern Barnet, N., clerk. The number of directors is not to be less than three nor more than five; the first are the first four subscribers; qualification, 100 shares; remuneration, £200 per annum, and a share in the profits, divisible.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Winchester Electric Light and Power Company, Limited (50,868).—This company's annual return was filed on November 1st, 1899, when 2,207 shares were taken up out of a nominal capital of £25,000 in 4,000 shares of £5 each. The full amount has been called up, resulting in the receipt of £10,875. £160 is owing.

CITY NOTES.

Alderley and Wilmslow Electric Supply, Limited.

THE annual meeting of shareholders of this company was held last week at 78, King Street, Manchester, Mr. F. E. Gripper presiding. Among those present were Messrs. A. Crewdson, W. P. J. Fawcus, P. Whyman, S. V. Clirehugh (consulting engineer), and W. E. Rowcliffe (secretary). From the report of the resident engineer it appeared that the works were giving every satisfaction, and the number of residents applying for the supply of electric light was increasing. Mention was also made that it was thought probable that application had been made for the supply to be extended to the district of Mobberley, but the directors had decided to obtain further particulars in regard thereto. The secretary reported that the company had entered into an agreement with the National Electric Wiring Company, Limited, for the free wiring of premises in the district, and this would enable intending customers to have the use of the fittings at a very small cost. It was also reported that the directors were in communication with the Wilmslow District Council with a view to make an arrangement for the supply of current to that district, in respect of which a provisional order had been obtained. The two retiring directors, Messrs. W. P. J. Fawcus and Philip Whyman were re-elected. Mr. A. A. Gillies was re-appointed auditor.

The Wireless Telegraph and Signal Company.

THE report of the directors for the year ending August 31st, 1899, states that the year that has passed must be considered as another year of experiment and development. But a foundation has now been laid on which a sound commercial business may be expected to be built at an early date. Since the last meeting communication has been established for the Trinity Board between the East Goodwin lightship and the South Foreland lighthouse, a distance of 12 miles;

and between the South Foreland and Wimereux, in France, a distance of 32 miles. Her Majesty's ships *Alexandra*, *Europa*, and *Juno* were fitted with apparatus, and under the personal charge of Mr. Marconi the system was made great use of during the subsequent naval manœuvres, signals being transmitted a distance of 70 miles. The results were most satisfactory, and it is expected that the company's system of wireless telegraphy will henceforth take its place as part of the equipment of Her Majesty's ships. The chief features of the meeting of the British Association at Dover during the year 1899 were the interchange of visits between the Association and the corresponding French Society, which held its annual meeting at Boulogne, together with the immense interest excited by the company's stations at the South Foreland and Wimereux. On November 2nd six assistants with apparatus sailed under agreement with H.M. War Office for South Africa. Naturally the experience of the company's assistants, under Mr. Bullocke, with the Marconi system for the first time in the field during active warfare is of very great interest. The shareholders will see from the notice convening the meeting that it is not intended to transact any business on Friday, December 29th, except to propose the adjournment of the meeting to a day to be fixed by the directors in January or February, 1900. At the adjourned meeting the directors will still place before the shareholders fully the position of the company, which they have every reason to believe will be found satisfactory. Manufacturing premises having been obtained at Chelmsford, machinery and plant have been installed, and the works are now in running order. The directors recommend that the name of the company should be changed into "Marconi's Wireless Telegraph Company, Limited," and will propose a resolution giving effect to their recommendation at the extraordinary meeting, which it is proposed shall be held immediately after the adjourned general meeting. Mr. William Smith has resigned the directorship, and Major Samuel Flood Page and Mr. Henry Spearman Saunders have joined the board. The directors retiring by rotation are Mr. William Woodcock Goodbody, who is eligible and offers himself for re-election, and Mr. Henry Jameson Davis. The auditors, Messrs. Cooper Bros. and Co., also retire, and offer themselves for re-appointment.

TRAFFIC RECEIPTS.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending December 23rd, 1899, were £122 16s. 10d.: December 23rd, 1898, £132 15s. 0d.; aggregate for half-year to date, £20,083 18s. 2d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending December 22nd, 1899, were £2,763 12s. 3d.; corresponding period, 1898, £2,729 15s. 7d.; increase, £33 16s. 8d.

The City and South London Railway Company.—The receipts for the week ending December 24th, 1899, were £1,194; December 25th, 1898, £1,134; increase £60. Total receipts for half-year, 1899, £25,995; total receipts corresponding period, 1898, £25,966; increase, £29. Miles open, 3½.

The Dublin United Tramways Company.—The receipts for the week ending Friday, December 2nd, 1899, were as follows:—D. U. T. Co., horse cars, £120 15s. 11d.; ditto, electric cars, £3,107 11s. 10d.; D. S. D. Co., electric cars, £647 9s. 0d.; total, £3,875 16s. 9d.; corresponding week last year—D. U. T. Co., horse cars, £2,202 1s. 7d.; ditto, electric cars, £587 12s. 9d.; D. S. D. Co., electric cars, £653 7s. 11d.; total, £3,443 2s. 3d.; increase, £432 14s. 6d. Aggregate to date, £103,752 8s. 1d.; aggregate to date last year, £98,249 15s. 9d.; increase to date, £5,509 12s. 4d. Worked:—The mileage open is 40 miles electrically, 4 miles by horses, as against 16 miles electrically, and 28 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways.—The receipts for the week ending December 24th, 1899, were £576; December 28th, 1898, £314; increase, £262. Number of cars, 1899, 28; 1898, 10. Total receipts to date, from April 1st, 1899, £22,794; 1898, from June 20th, 1898, £6,858. Miles of track open, 12; 1898, 3¼.

The Liverpool Overhead Railway Company.—The receipts for the week ending December 24th, 1899, amounted to £1,442; corresponding week last year, £1,439; increase, £3.

The South Staffordshire Tramways Company.—The receipts for week ending December 23rd, 1899, were £623 12s. 5d.; December 28rd, 1898, £685 8s. 7d.; aggregate receipts for 51 weeks £33,801 14s. 9d; 1898, £32,188 6s. 4d.

STOCKS AND SHARES.

Wednesday Evening.

In giving a very short *résumé* of the principal movements in the electrical markets during the present year, we must preface our list of tables with the general remark that 1899 has been an unfortunate twelvemonth for those who have money invested in this description of security. Politics, dear money, war—have played their parts in reducing values, and it is only natural, under the circumstances, that prices should have given way. To take the little electrical railway market first, we give the closing prices of last year side by side with the opening quotations of December 27th, 1899.

Railway.	Dec. 31st, 1898.	Dec. 27th, 1899.	Fall.
City of London	68	60½	7½
Central London	10	9⅜	⅝
Waterloo and City	112½	101½	11

The fall in price notwithstanding, there has been a great increase in the number of electrical and other light railways under construction; most of the enterprises met with poor receptions from the public, but the work has been taken in hand by other companies and financiers, and any revival of interest in this class of investment will quickly find itself confronted with plenty of new outlets for its capital.

Turning to the market for supply shares, there is another list of falls to be put upon record, thus:—

Company.	Dec. 31st, 1898.	Dec. 27th, 1899.	Rise or fall.
City of London	23	10½	−12½
Charing Cross	12	10	− 2
Chelsea	9½	8	− 1½
Metropolitan	18	13⅝	− 4⅜
County Brush Ordinary	13	10⅝	− 2⅜
St. James's and Pall Mall	16½	15½	− 1
Westminster	16	14	− 2

The end of last year, it must be remembered, saw this section in what might almost be called a state of boom. The unhealthy activicy then developed has softened down into a much more chastened frame of mind in the Stock Exchange, and the uninteresting dividends declared by the various companies showed that trade was not rushing up as quickly as prices. Among the principal features of the year has been the excitement produced by the Charing Cross Company obtaining permission from the Corporation to compete with the City of London Company on its own ground. In consequence of this the latter company passed its dividend in September, and the year's concatenation of misfortunes has caused a fall of £12 10s. in the price on the year.

Several of the companies have added to their capital during the year, the House-to-House, whose shares stood at 9½ on December 31st last, has changed its name to the Brompton and Kensington Electric Supply; the price of the shares has fallen to £8.

Telegraph stocks have indulged in all kinds of vagaries. The general tendency has been downward, and the fall started with apprehensions as to what might be the effect upon telegraph companies if wireless telegraphy should come to supersede the older method of communication. Another scare was begun at the proposal to lay a new all-British cable, and these two causes, added to dear money, are responsible for a good deal of the fall which we have to chronicle.

Company.	Dec. 31st, 1898.	Dec. 27th, 1899.	Rise or fall.
Anglo "A"	17	15½	− 1½
Anglo "B"	116½	112	− 4½
Eastern Ordinary	175½	145½	− 30
Eastern Extension	17½	14½	− 3½
Brazilian Submarine	15½	14¼	− 1¼
Great Northern of Copenhagen	29	32	+ 3

The Western and Brazilian has been absorbed by the Brazilian Submarine Company. Anglo-American stocks were largely bought in anticipation of a better award for the "A" class, but latterly the slump in Yankee Rails, and the general frightened state of the Stock Exchange produced by British reverses in the Transvaal, have combined to lower these prices, together with nearly everything else, Great Northern of Copenhagen being a remarkable exception.

The miscellaneous section has passed a quiet and uneventful year. The country's trade has improved, which naturally brings increased prosperity to the more commercial companies, but this department has also suffered from the war and from the effects of the 6 per cent. Bank rate. Selecting six or seven of the most representative shares, we present another little list:—

Company.	Dec. 31st, 1898.	Dec. 27th, 1899.	Rise or fall.
British Electric Traction	16	15½	− ½
Brush	1⅞	1⅞	+ ⅛
New General Traction	5	3⅝	− 1⅜
Edison & Swan "A"	2¼	2⅛	− ⅛
Babcock & Wilcox	27½	43	+ 15½
Electric Construction	2⅜	2¼	− ⅛
Henley's	22½	12½ (= 25)	+ 2½
Telegraph Construction	39	38	− 1

The wonderful rise in Babcock & Wilcox shares is due to the equally wonderful development of the company's business. A rise of 15½ points in such a quiet year is in itself sufficient congratulation to the shareholders without further comment. The Henley Telegraph Company has rearranged its capital, reducing the Ordinary shares from their £10 level to a denomination of £5. Elaborate proposals with regard to the Elmore companies have had no effect upon the price of the Patent Copper Depositing shares. National Telephones have fallen from 5⅝ to 4¾, partly on account of the agitation in favour of the Government taking control of the telephone system.

Although prices at the end of the year are weak, the markets are in a perfectly sound condition, and if the Transvaal matter be quickly and satisfactorily settled, there is little doubt that 1900 will set a brighter complexion upon the general aspect of financial affairs.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, Dec. 20th.	Closing Quotation, Dec. 27th.	Business done during week ended Dec. 27th, 1899. Highest.	Lowest.
124,400£	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs., Nos. 1 to 1,250 Red	100	...	...	...	85 — 90	85 — 90	...	...
905,560£	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	63 — 66	62 — 65	...	...
3,047,220£	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	113 —115	111 —113	113½	111½
3,047,220£	Do. do. Deferred...	Stock	...	...	18s. %	15½— 16	15¾— 16¼	16	15½
205,151	Brazilian Submarine Telegraph	10	7 %	7 %	...	14½— 14¾xd	14 — 14½	14⅜	14¼
75,000£	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	107 —111	107 —111	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2 — 3	2 — 3	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	8 %	198 —202	198 —202	...	...
1,332,523£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	103 —105	100 —103	...	...
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	1½ %	1 %	¼— ¼	¼— ¼	...	...
16,000	Cuba Telegraph	10	8 %	7 %	8 %	8¼— 9½	8½— 9½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	103 —107%	103 —107%	...	...
60,710£	Direct United States Cable	20	3 %	3¼%	3¼%	11¾— 12¼	11½— 12	...	...
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	101 —104	101 —104	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	6½%	7 %	7 %	145 —150	143 —148	146	145
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	98 —101	97 —100	...	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	... ...	... ...	...	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	115 —120	115 —120	116½	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	14¾— 15¼	14¼— 14¾	14 13/16	14½
16,200£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	99 —103	99 —103	...	...
64,400£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	116 —121	116 —121	...	...
85,100£	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	99 —103	99 —103	...	...
46,500£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	100 —103	100 —103	...	...
800,000£	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	101 —104	101 —104	...	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	101—104%	101 —104%	...	...
180,227	Globe Telegraph and Trust	10	4½%	4½%	5½%	10⅜— 11¼	10⅜— 11¼	11⅞	...
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	14⅜— 15½	14⅜— 15½	15	...
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	31 — 33	31 — 33	...	...
86,300	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	48 — 52	48 — 52	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	106 —109	106 —109	...	...
71,000	Montevideo Telephone, Limited, Ord., Nos. 1 to 71,000 ...	1	...	...	...	¼— ½	¼— ½	...	...
84,000	Do. do. 5% Pref., Nos. 1 to 84,000	1	...	...	...	¾— 1	¾— 1	...	...
490,000	National Telephone, 1 to 490,000	5	5½%	6 %	6 %	5 — 5¼	4⅞— 4⅞	4⅞	4¾
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	14 — 15	14 — 15	14	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 15	14 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅛— 5⅜	5⅛— 5⅜	5 3/16	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	100 —102	100 —102	99¾	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	¾— 1	¾— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	...	102 —105	102 —105	...	...
11,839	Reuter's	8	5 %	5 %	...	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	125 —130	125 —130	...	...
58,000	United River Plate Telephone	5	5 %	6 %	...	4⅜— 5¼	4⅜— 5¼	...	...
151,783£	Do. do. 5 % Debs.	Stock	...	..	...	105 —108	105 —108	...	...
200,000£	West African Telegraph, 5 % Debs.	100	5 %	%	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	102 —105	102 —105	...	...
389,521	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
88,321	West India and Panama Telegraph	10	1 %	⅜%	...	⅞— 1⅛	⅞— 1⅛	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	9¼— 9⅜	9¼— 9⅜	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	7⅞— 8½	7⅞— 8½	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	106 —109	106 —109	...	...
158,100£	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	...	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	...	4 %	6 %	7½— 8½	7½— 8½	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	...	9 — 10	9 — 10	...	...
80,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	9½— 10½	9½— 10½	9½	...
20,000	Do. do. do. do. Nos. 30,001—50,000	5	...	...	...	9½— 10½	9½— 10½	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	5⅝— 6¼	5½— 6	5⅝	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	6 %	6 %	7½— 8½	7½— 8½	...	...
100,000	Do. do. do. % Deb. Stock Red....	Stock	4½ %	4½ %	...	109 —111 xd	109 —111 xd	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	7 %	10 %	6 %	10 — 11	10 — 11	10 9/16	10½
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	13 — 14	13 — 14	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	125 —130	125 —130	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	nil	nil	10 — 11	10 — 11	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	13 — 14	13 — 14	...	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	110 —113	110 — 113	...	...
26,100	Edmundsons Elec. Corp., Ord. Shares	5	...	5 %	7 %	4⅜— 5¼	4⅜— 5¼	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	2¼— 2⅝	2¼— 2⅝	...	...
48,050	Do. do. do. 6 % Pref.	5	...	...	6 %	5½ — 6	5½ — 6	...	...
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	102 —104 xd	102 —104 xd	103	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	5 %	13 — 14	13 — 14	13¾	...
22,500	Do. Nos. 62,501 to 85,000	10	...	...	...	13 — 14	13 — 14	...	...
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½%	4½%	...	117 —119	117 —119	...	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	6 %	15½— 16½	15½— 16½	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½%	14½%	14½%	15 — 16	15 — 16	...	...
30,000	Do. do. 7 % Pref., 30,081 to 40,080	5	7 %	7 %	7 %	9 — 9½	9 — 9½	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	4¼— 4⅝	4¼— 4⅝	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	9 %	12 %	12 %	13½— 14½	13½— 14½	...	...

* Subject to Founder's Shares.
Unless otherwise stated all shares are fully paid.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation Dec. 20th.	Closing Quotation Dec. 27th.	Business done during week ended Dec. 27th, 1899. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	10 %	10 %	...	2⅜— 3¼	2⅜— 3¼	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	95 —100	95 —100	...	...
30,000	British Electric Traction	10	...	...	6 %	15 — 16	15 — 16	15½	15⅜
30,000	Do. do. 6 % Cum. Pref. 30,001—60,000	10	...	...	...	12½— 13¼	12⅜— 13¼	...	...
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	125 —128	125 —128	127	126½
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	...	...	...	11½— 12½	11½— 12½	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,500 ...	5	...	...	...	6½— 6⅝	6½— 6⅝	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	*nil*	3 %	5 %	1⅝— 2	1⅝— 2	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	4 %	6 %	6 %	2⅜— 2⅜	2⅜— 2⅜	...	...
125,000£	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —115	110 —115	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	10 %	12½%	15 %	12½— 13½	12½— 13½	...	...
20,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	...	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	113 —116	113 —116	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	9⅜— 10¼	9⅛— 10	10	9 11/16
178,303	Do. do. do. £8 paid	10	...	...	...	...	...	...	...
61,033	Do. do. Pref. half-shares	5	...	...	...	4⅛— 5	4⅛— 5	...	...
71,447	Do. do. Def. do.	5	...	...	...	4⅜— 5	4⅛— 5	...	...
630,000£	City and South London Railway	Stock	1 5/16%	1¼%	2⅛%	59 — 62	59 — 62	...	...
37,000	Do. do. Ord. shares, Nos. 22,501 to 60,000	4½	...	...	...	3½— 4½	3½— 4½	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	3½— 4	3½— 4	...	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	100 —103	100 —103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5½%	6 %	6 %	2 — 2⅛	2 — 2⅛	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5½%	6 %	6 %	3½— 4½	3½— 4½	...	...
344,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	95 — 97	95 — 97	...	...
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2 — 2⅛	2 — 2⅛	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	2⅜— 3¼	2⅜— 3¼	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	104 —107	104 —107	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅜— ⅝	⅜— ⅝	...	...
9,600£	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	7 %	10 — 12	10 — 12	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	10 %	12 %	14 %	12 — 13	12 — 13	...	...
15,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	7 %	5 — 5½	5 — 5½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	...	111 —114	111 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21 — 22	21 — 22	...	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	100 —104	100 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2½%	3½%	3½%	8 1/16— 8 15/16	8 1/16— 9 1/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	13⅛— 13⅝	13⅛— 13⅝	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	36 — 40	33 — 37	36	...
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	103 —106	103 —106	...	...
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	9 — 10	9 — 10	...	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5½— 6	5½— 6	...	...
540,000£	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	100 —103	100 —103	...	...

† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½% Debentures of £100, 104—107.
National Electric Free Wiring, 10s. paid, ⅛—⅜.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 18—19.
Do. do. Pref. (£10 pd.), 10½—11.
Smithfield Market Electric, 1—3.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6%, £5 (fully paid), 7⅛—8. Debentures, 104—107. Dividend, 1898, on Ordinary Shares 10%.
Kidderminster and District Electric, Pref. (£6 pd.), 6—6½.
*T. Parker, £10 (fully paid), 18⅜.

* From Birmingham Share List.

Bank rate of discount 6 per cent. (November 30th, 1899).

MARKET QUOTATIONS, Wednesday, December 27th.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a „ Nitric .. .. .. per cwt.	22/-	22/-	..
a „ Oxalic .. .. .. per cwt.	32/-	32/-	..
a „ Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	40/-	40/-	..
a Ammonia, Muriate (crystal) .. per ton	£29	£29	..
a „ „ .. .. per ton	£27	£27	..
a Bleaching powder .. .. per ton	£6 10	£6 1	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a „ (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£25 10	£25 10	..
a Lead, Nitrate .. .. .. per ton	£25	£25	..
a „ White Sugar .. .. per ton	£31	£31	..
a „ Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	4½d.	4½d.	..
a „ Caustic (75/80 %) .. per ton	£24	£24	..
a „ Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	68/-	68/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6	£6	..
a „ Recovered .. .. per ton	£5 10	£5 10	..
a „ Lump .. .. .. per ton	£5	£5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
Crystals .. .. .. per ton	£3	£3	..
a „ Bichromate, casks .. per lb.	3¾d.	3¾d.	..
METALS, &c.			
Aluminium Wire, in ton lots .. per ton	£224	£224	..
b „ Sheet, in ton lots.. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£70 to £125	£70 to £125	..
c Brass (rolled metal 2' to 12') basis per lb.	8d.	8d.	..
c „ Tube (brazed) .. .. per lb.	10d.	10d.	..
c „ Wire, basis .. .. per lb.	8½d.	8½d.	..

METALS, &c. (*continued*).	This week.	Last week.	Inc. or Dec.
f Ebonite Rod .. .. .. per lb.	8/-	8/-	..
f „ Sheet .. .. .. per lb.	6/-	6/-	..
g Copper Bars .. .. .. per ton	£85	£85	..
g „ Wire (basis price) .. per lb.	10½d.	10½d.	..
g „ Sheet .. .. .. per ton	£95	£95	..
g „ Rod .. .. .. per ton	£85	£85	..
m German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	7/-	7/-	..
h India-rubber, Para fine .. per lb.	4/6½ to 4/7½	4/6½ to 4/7½	..
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i „ Pig (Cleveland warrants) per ton	64/6	64/6	..
i „ Forgings, according to size per ton	From £11	From £11	..
i „ Scrap, heavy .. .. per ton	50/- to 55/-	50/- to 55/-	..
i „ Wire galvanised No. 8 .. per ton	£14 5	£14 5	..
g Lead, English Ingot .. .. per ton	£16 10	£17 10	£1 dec.
g „ „ Sheet .. .. per ton	£18	£19	£1 dec.
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£9 12 6	£9 12 6	..
d Mica (in original cases), small per lb.	2d. to 8d.	2d. to 8d.	..
d „ „ „ medium per lb.	1/9 to 2/9	1/9 to 2/9	..
d „ „ „ large per lb.	8/6 to 7/6	8/6 to 7/6	..
p Phosphor Bronze, plain castings per lb.	1/1 to 1/4	1/1 to 1/4	..
p rolled bars & rods per lb.	1/1 to 1/4	1/1 to 1/4	..
p „ r'l'd str'p & sheet per lb.	From 1/2½	From 1/2½	..
o Platinum .. .. per oz.	£3 11	£3 11	..
p Silicium Bronze Wire .. .. per lb.	10½d. to 1/1	10½d. to 1/	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15 to £40		..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£108 to £110 nom.	£124 5 nom.	dec.
g „ foil .. .. per lb.	1/7	1/7	..
n „ wire Nos. 1 to 16 .. .. per lb.	1/8	1/10	2d. dec.
p White Anti-friction Metals— "White Ant" brand .. per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	7¾d.	7¾d.	..
j „ Best Flax, 6 lea. .. per lb.	5d.	5d.	..
j „ Hemp, 3 ply 10 lbs. .. per lb.	3¼d.	3¼d.	..
j „ „ Russian, 10 lbs. per lb.	4½d.	4½d.	..
j „ Jute, 180 lbs. rove .. per ton	£14	£14	..
k Zinc, Sheet (Vielle Montagne bnd.) p.t.	£24 5s.	£24 3 nett.	2s. inc.

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yeo & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

SUPPLEMENTS TO RAILWAY SIGNALLING (BRIERLEY'S APPARATUS).

The whole of the elaborate system of railway signalling, consisting of simple block, automatic or semi-automatic block, where in use, interlocking, has as its object the exhibition of appropriate outdoor signals for the guidance of the drivers of trains. Such signals, as is well known, are visual signals, and when fogs or snowstorms are prevalent they are, as is also well known, supplemented by others which depend upon the train passing over detonators placed on the rail by hand, and thus giving an explosive danger signal. Much—so very much—might be written in criticism of the existing method of signalling during fogs, &c., but probably enough has been said. It

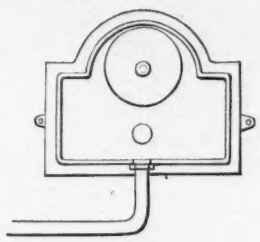


Fig. 1.

need, therefore, for the purpose of this article, only be remarked that since men have to be drawn from other occupations during the day, and from their homes at night, there is always a chance that it may not be immediately available; that the "all right" signal being conveyed by the absence of an indication is of a negative character, liable to misinterpretation, and is of no avail for localisation; and that the signalman who directs the operations has no actual control over the indications given, and therefore transmits his signals through a medium which is liable to err.

Something, of course, has been done in various places to put the operation of depositing explosive signals in position into the hands of the signalman, and instances are not wanting in which such mechanical arrangements have done excellent service. They, however, largely depend upon the efficient working of mechanisms, or the medium of operation, which cannot always be depended upon, especially for long distances; the receptacles can only hold a certain number of detonators and have to be refilled at intervals; and the signalman has no certainty that the operations he has gone through will have the effect intended, as he is unable to see the result of these operations. Besides all this, such arrangements, when made, make no change in the character of the signalling to the driver, and it is in this respect that those who have given attention to the subject consider the existing system most inadequate.

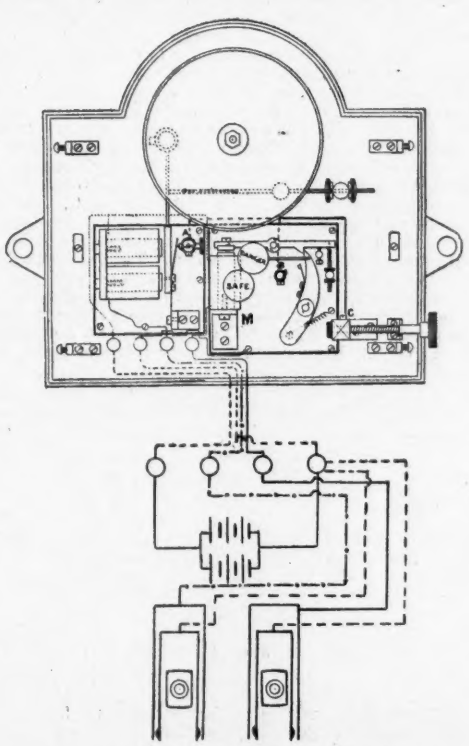
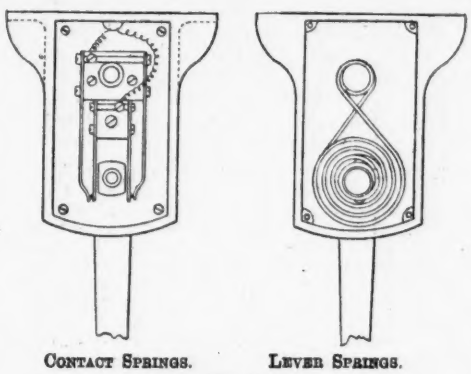


Fig. 2.—"All Right": Danger, Line Contacts.

There is no lack of substitutes, nowadays, for the ordinary form of fog signalling. Mr. Boult's system has been tried, and described in these columns. Raven and Baister's system has been tried on the North-Eastern; the Great Eastern, was reported some time ago to be contemplating the use of electric warning bells placed somewhere in the neighbourhood of the signals to be indicated; the system about to be described has been under trial on the Great Northern for 12 months, and there are other suggestions more or less varied. Somehow, however, no real progress seems to be made, and the old system retains its hold, probably on account of an innate dislike of change, and the trouble involved in making experiments which, after all, may prove abortive. There is, of course, something to be said for such an attitude. The percentage of accidents to the number of trains run under the existing system is undoubtedly low; railway companies do not indulge in the luxury of an experimental staff, and the departmental officers have usually as much on hand as is good for them; and the inventor, wherever found, is usually an optimist in so far as his own apparatus is concerned. It would, of course, be easy to meet these objections in detail, but there is no necessity to do so in the present case.

Suggestions for substitutes for the ordinary signals, may be divided, primarily, into two classes: those which give the desired indication on the engine of the train signalled, and those which give the indication external to the engine. Of the first class, Boult's, and



Contact Springs. Lever Springs.

Fig. 3.

Raven and Baister's, are types (neglecting the system to be described for the present). Of the second class the ordinary detonator, and the warning bells, are examples. The first class may be further divided into those which give the signal, primarily, through the impact of some part of the moving train against an obstruction purposely placed on the side of the line, and those which do not require such an impact. Raven and Baister's is an example of the first subdivision, and Boult's of the second. Several other distinctions might be drawn between the different classes of apparatus, but enough has been said for the present purpose.

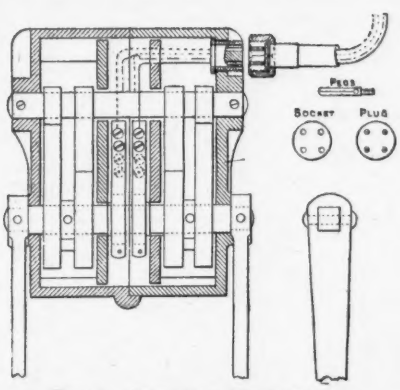


Fig. 4.—Section of Lever Box.

Brierley's system, which is being introduced by Messrs. Saxby and Farmer, has been under trial on the Great Northern for about 12 months, and is said to have given great satisfaction, and to have been inspected and approved by an inspector of the Board of Trade. The system is one which depends upon the movement of normally balanced levers, fixed on the engine, by impact with obstructions placed on the line side, and gives appropriate indications, on the engine itself, of the positions of the ordinary signals. The movement of the levers is made to close electrical circuits on the engine, and the indications are given by the ringing of an electric bell and the appearance of discs, which, by convention, convey the information desired. The apparatus is capable of giving two indications to the driver, corresponding to the "all right" and "danger" positions of the ordinary signal arms. The former indication is given by the bell ringing a short time only, and no change in the disc exhibited.

The latter indication is given by continuous ringing of the bell until stopped by the driver, and the substitution of a red disc for the white one exhibited at all other times. The normal indication exhibited by the white disc is "all right," and the ringing of the bell when a signal in that position is being approached may be considered as confirmatory only. When the "danger" indication is being exhibited, and the bell is ringing, the apparatus may be replaced into its normal position at any time.

Such, briefly, are the objects sought and attained. The means by which they are obtained are of a very simple character.

Fig. 1 shows the outer form of the indicating apparatus; the lower circle on the front representing the window at which the discs (white and red) appear. Fig. 2 shows the indicating apparatus, and a diagram of the electrical circuits to which reference will be made later. Fig. 6 shows the balanced levers (2), the box containing

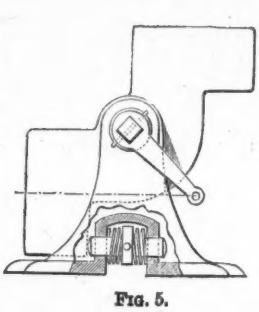


FIG. 5.

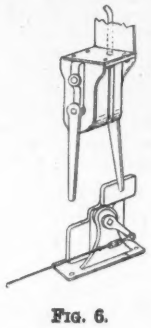
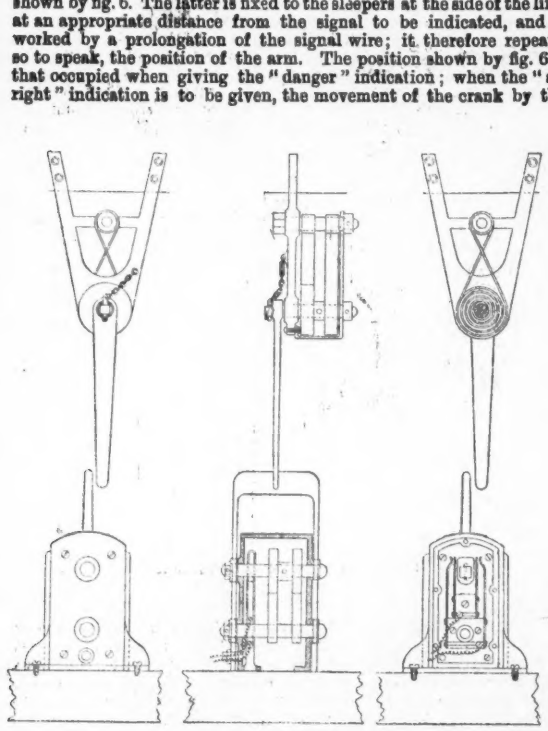


FIG. 6.

the circuit closing apparatus, and the means by which the levers are balanced, and the force of the impact, over and above that required to give the necessary movement, taken up. Further details of this part of the apparatus are shown by figs. 3 and 4, which are sections of the box. Reference to these shows that there are in each box four points at which contact is made, but only two circuits, and that in whatever direction a lever is moved the electrical results are the same. Figs. 3 and 4 show that the control of the levers consists of two volute springs in reversed order. One end of each spring is fastened to the shaft carrying the two levers, and the other ends are fastened to a bar above. Hence movement of either bar in either direction is checked by a spring. Save for the control exercised by the springs the levers are free.

The lever box is carried on the engine in an appropriate position to allow the lever bars to engage the arms of the contact rocker shown by fig. 6. The latter is fixed to the sleepers at the side of the line, at an appropriate distance from the signal to be indicated, and is worked by a prolongation of the signal wire; it therefore repeats, so to speak, the position of the arm. The position shown by fig. 6 is that occupied when giving the "danger" indication; when the "all right" indication is to be given, the movement of the crank by the



FIGS. 7, 8 AND 9.

wire from the signal reverses the position of the rocker, and the front lever, as seen in the figure, is engaged. The position shown by fig. 6 may be said to be the normal position, since that is the position the rocker takes up naturally, owing to a difference in the weights of the arms. In this respect the normal position of the rocker corresponds to the normal position of the signal, and failure of the wire operating either or both, results in a "danger" indication being given.

Turning next to fig. 2, it will be seen that the apparatus consists of an ordinary make and break bell (which, however, in giving one of the indications, acts as a single stroke bell only), a second electro-magnet, M, the armature of which controls the position of a curved lever, which itself is a circuit closer, and the means by which the discs are mechanically actuated. A plunger is also shown at the side by which the curved lever may be mechanically replaced in the position shown in fig. 2 at any time after having been released by M. This plunger is also a circuit closer.

A little consideration of fig. 2 shows that the closing of the "all right" circuit causes a current to pass through the *coils* of the bell. Under these conditions the bell acts as a single stroke bell only, but inasmuch as the lever arm will necessarily oscillate for some time, the circuit will be closed each time the lever passes its normal position, and the bell will ring under the impulses of the discontinuous currents set up. The time is about two seconds, and this is also a measure of the time required by the lever to take up its normal position after being struck. It will be noticed that this is the only electrical action for this indication.

If the "danger" position is being indicated a circuit through M is first closed, and the armature releases the curved lever. The fall of the latter causes the red disc to replace the white, and also closes a second circuit through B, A, the make and break, and the bell coils, thus causing the bell to sound. This local circuit is dependent upon

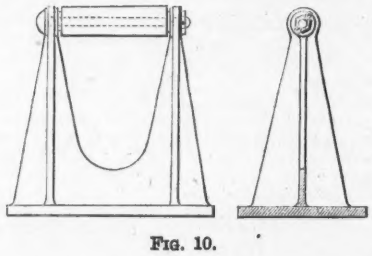


FIG. 10.

the position of the curved lever, and independent of the contact made in the lever box. Hence the bell will continue to ring until the curved lever is replaced. This, as already mentioned, is effected by the use of the plunger, acting mechanically on the lower end of the curved lever. The latter operation restores the white disc to the window. The use of the plunger to replace the apparatus completes the cycle of operations, but it should also be mentioned that as the plunger completes the same local circuit as is completed by the falling of the curved lever, the use of the plunger affords a means of testing, at any time, of, at least, a portion of the apparatus.

A very large number of points arise for consideration in connection with apparatus for such a purpose, but there is no intention of discussing them fully here at present. Mr. Brierley's system, it is understood, has been under trial on 25 miles of the Great Northern Railway, and is said to have given satisfaction, and to have been approved by an inspector of the Board of Trade. It is also said that those who are entitled to an opinion on the adequacy of such apparatus, speak highly of it after seeing it. To have obtained such commendation is in itself an achievement of no mean order.

It would, however, be interesting to know what number of engines were fitted with the apparatus and the number of times they ran over the fitted portion of the line, the speeds, and the character of the trains. It will be noticed that either the lever boxes or the

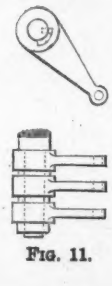


FIG. 11.

contact rockers would require to be in duplicate, for universa application, since engines sometimes run tender first. In other systems requiring impact breakages of the levers has not been infrequent. It is difficult to see how the volute springs used for balancing the levers can minimise the *blow* sustained, since this is practically instantaneous. Only by lengthening the time occupied in completing the contact between the lever and the rocker can the effect of the *blow* be lessened. The springs can only take up the energy imparted to the lever.

The apparatus, whilst it provides "all right" and "danger" indications, takes no notice of the fact that some signals are not *stop* signals, even when they occupy the "danger" position. Some such discrimination would seem to be necessary in cases where localisation of position is difficult.

Again, fig. 11, which is called a signal selector, illustrates another

difficulty. The apparatus is not a signal selector in the same sense as Sykes's apparatus bearing that name, but is simply a device for reducing the number of rockers on a line leading to a diverging junction, to one, no matter how many lines may diverge, and, consequently, how many signals there may be. This apparatus illustrates the point that a driver approaching a diverging point not only requires to know that *a* signal is off, but that *the* signal he requires is in that position. Under ordinary conditions he obtains this information from the positions of the signals relatively to each other, but no number of contact rockers will give him this information, with only one set of indicating apparatus on the engine.

Again, the provision of a means of replacement by hand, for the indicating apparatus after a "danger" indication has been received, seems to be a matter that would require grave consideration.

Many other points than those merely touched upon arise, but it is impossible to discuss them at length. Mr. Brierley's apparatus is not confined to fog signalling alone. Adaptations of it are claimed as useful for other purposes, such as "last vehicle" indicators (figs. 7, 8 and 9), and alarms for use when platelayers are at work on the line—which is always. With reference to the former it need only be said that, as with previous suggestions, duplication of the carrying parts is necessary; and with reference to the latter it may be pointed out that where an alarm is desirable—and it should be compulsory in some cases—it is the platelayer who should be warned, and not the engine driver. Where renewals of the line are in progress, and cautionary signals are to be given, it is desirable that they should be of a character entirely distinct from the ordinary signals in order to prevent confusion.

CALCULATION OF THE ELECTROMOTIVE FORCE OF BATTERIES BY THE THERMIC CONSTANT METHOD.

By Dr. D. TOMMASI.

In order to calculate the electromotive force of batteries by the thermic constant method, it is necessary to know, in the first place, the numerical relations that exist between certain thermic data.

These various numerical relations may be expressed by the following law, which I discovered in 1882.*

"*When one metal is substituted for another in a saline solution, the heat given off is for each metal the same, whatever may be the nature of the acid base that forms a part of the salt.*" †

Zinc, for instance, on being substituted for copper in sulphate of copper, gives off 50·6 calories; now, the substitution of zinc for copper in any other soluble compound of copper will always give off this same quantity of heat.

If we take cadmium instead of zinc, we find 33·8 calories, and this thermic value will be the same for all the salts of copper. It would be the same for all metals capable of substitution, not only in a solution of copper, but in any saline solution whatever.

Moreover, we know from the laws of thermo-chemistry that the heat given off by the substitution of zinc in sulphate of copper is equal to the difference between the heat of formation of sulphate of zinc and that of sulphate of copper.

From the principles that I have just explained, it must follow that if the difference between the heats of formation of sulphate of zinc and sulphate of copper is equal to 50·6 cals., this quantity will also represent the difference between the heats of formation of chloride of zinc and chloride of copper, bromide of zinc and bromide of copper, acetate of zinc and acetate of copper.

Speaking generally, if we call B, B′, B″ the acid bases and M, M′, M″ the metals, we shall get

$$c\,B\,M - c\,B\,M' = c\,B'\,M - c\,B'\,M'. \ddagger$$

Working on these principles I drew up the following table, by the aid of which the heat of formation of all soluble mineral and organic compounds can be determined *a priori*.

I obtained this table by subtracting from the heat of formation of chloride of potassium in solution the heat of formation of other chlorides in solution. Thus the value 88·8 cals. placed in the table opposite the zinc expresses the difference between

$$2\,c\,Cl\,K - c\,Cl_2\,Zn = \theta\,Zn.$$

The figures 4·6 cals., placed opposite the sodium, express the difference between

$$c\,Cl\,K - c\,Cl\,Na = \theta\,Na.$$

Table of Thermic Constants.

General formula: $c\,\Delta = \delta - \theta$. Δ = a salt, of which we wish to find the heat of formation, δ the heat of formation of the salt of potassium, having the same acid base as the salt Δ, θ the thermic constant corresponding to the base of the salt Δ.

Value of θ as compared with the molecular weight of the salts in solution.

Salts of sodium	4·6	cals.
„ „ silver	87·4	„
„ „ thallium	62·3	„
„ „ magnesium	14·6	„
„ „ strontium	6·0	„
„ „ calcium	14·0	„
„ „ zinc	88·8	„
„ „ cadmium	105·4	„
„ „ iron	101·6	„
„ „ manganese	73·6	„
„ „ nickel	108·0	„
„ „ cobalt	106·8	„
„ „ copper	139·0	„
„ „ lead	123·2	„
„ „ tin	120·4	„
„ „ hydrogen, or acids	61·5	„

I will now show by a few examples taken at random the accuracy of this law, and at the same time indicate how the table of thermic constants should be used. We will suppose that we have to determine the heat of formation of sulphate of copper in solution. According to the general formula, we should get

$$c\,SO_4\,Cu = c\,SO_4\,K_2 - \theta\,Cu.$$

$$c\,SO_4\,Cu = 196\text{ cal.} - 139\text{ cal.} = 57\text{ cal.}$$

Result obtained by experiment 56·8 cal.

For the heat of formation of nitrate of cadmium we should get

$$c\,(N\,O_3)_2\,C\,\delta = 2 \times c\,N\,O_3\,K - \theta\,C\,\delta.$$

$$c\,(N\,O_3)_2\,Cd = 2 \times 96{\cdot}1\text{ cal.} - 105{\cdot}4 = 86{\cdot}8\text{ cal.}$$

Result obtained by experiment 86·6 cal.

For the heat of formation of iodide of calcium, we should get

$$c\,I_2\,Ca = 2 \times c\,I\,K - \theta\,Ca.$$

$$c\,I_2\,Ca = 2 \times 74{\cdot}7\text{ cal.} - 14\text{ cal.} = 135{\cdot}4\text{ cal.}$$

Result obtained by experiment 135·4 cal.

I could certainly add to these examples, but it would be quite superfluous. By using the general formula and following the indications that I have given, it will be easy to *check*, to *determine* or to *foretell* the heat of formation of *all* the soluble salts.

I will now show how the law of thermic constants can be applied to the calculation of the electromotive force of all batteries in which *the whole of the chemical energy is convertible into electrical energy.*

Electromotive Force of Batteries with Two Liquids.

When a battery is formed of two metals each dipping separately into the solution of one of its own salts, and when these salts have the same acid or the same halogenous body, the electromotive force of this couple is equal to the difference of the thermic constants of these metals divided by the volt expressed in calories or v.

If we call E the electromotive force of a battery constituted under the conditions that I have just described, and θ, θ' the thermic constants of the two metals, we shall get the following very simple expression:—

$$E = \frac{\theta - \theta'}{V}.$$

The volt V corresponds to 46·3 calories.

It must be observed that the three first metals mentioned in the table are mon-atomic, and all the others are di-atomic. The constants, θ and θ', belong, therefore, to metals of either category; the two metals of a battery may be mon-atomic or di-atomic. It follows that whenever the thermic constant of one of the latter enters into the above formula, the thermic constant of the mon-atomic metal must be doubled. It is the same when the two metals composing the couple are mon-atomic.

We will suppose that it is required to find the electromotive force of the couples sodium-silver, magnesium-silver, zinc-magnesium, each metal dipping into the solution of its own salt; we shall get:—

$$\text{Sodium-silver: } E = \frac{2 \times 87{\cdot}4 - 2 \times 4{\cdot}6}{46{\cdot}3} = 3{\cdot}57\text{ volts.}$$

$$\text{Magnesium-sodium: } E = \frac{14{\cdot}6 - 2 \times 4{\cdot}6}{46{\cdot}3} = {\cdot}12\text{ volt.}$$

$$\text{Zinc-magnesium: } E = \frac{88{\cdot}8 - 14{\cdot}6}{46{\cdot}3} = 1{\cdot}6\text{ volt.}$$

Of the two metals, the one with the lower thermic constant constitutes the negative pole of the couple, and is also the one which is dissolved, while the other constitutes the positive pole and is augmented by the deposit resulting from the decomposition of its salt. From the law given above it follows that: *the electromotive force of any couple formed of two metals, each metal dipping into the solution of its own salt, is always the same whatever the acid or the halogenous body of their two salts may be.*

Thus, for instance, for a cadmium-zinc couple, the electromotive force will always be

$$E = \frac{105{\cdot}4 - 88{\cdot}8}{46{\cdot}3} = {\cdot}31\text{ volt,}$$

whether the salts employed be sulphates, chlorides, acetates, &c.

The general formula of the electromotive force of any couple formed of two metals, A and B, is therefore:—

$$E = \frac{\theta - \theta'}{V} = x\text{ volts.}$$

I will now apply this formula to the calculation of a couple, the

* See *Comptes Rendus de l'Académie des Sciences de Paris*, for July, 1882.

† For further details see Traité de l'Electrochimie, by Dr. D. Tommasi, p. 857.

‡ The letter *c* placed before a salt indicates the heat of formation of that salt.

electromotive force of which has been accurately determined by experiment, *i.e.*, the Daniell couple.

As we know, this couple is formed of copper and zinc, each metal dipping into the solution of its own sulphate.

According to the above reasoning, the electromotive force will be:—

$$E = \frac{\theta\ Cu - \theta\ Zn}{V}$$

or, $$E = \frac{139 - 88{\cdot}8}{46{\cdot}3} = 1{\cdot}084 \text{ volt.}$$

The values of the electromotive force of the Daniell element obtained by various writers are as follows:—*

Electromotive forces.		Writers.
1·058 volts	... ...	Fleeming-Jenkin.
1·059 „	... ...	Favre.
1·059 „	... ...	Kittler.
1·079 „	... ...	Clark & Sabine.
1·101 „	... ...	Ledeboer.
1·155 „	... ...	Everett.
1·160 „	... ...	(†)

Electromotive Force of Batteries with a Single Liquid—*When a battery is formed of a single liquid, its electromotive force is equal to the difference of the thermic constants of the metal attacked, and of the hydrogen given off, divided by the volt expressed in calories.*

We must, however, except acids that can be reduced by hydrogen, or, more correctly, by H + cal., as would be the case with chromic acid, nitric acid, &c.‡

I will now suppose that it is required to determine the electromotive force of the zinc-copper couple with dilute sulphuric acid.

According to the general formula, we should get

$$E = \frac{2\theta H - \theta Zn}{V},$$

or $$E = \frac{2 \times 61{\cdot}5 - 88{\cdot}8}{46{\cdot}3} = 0{\cdot}738 \text{ volt.}$$

The electromotive force of this same couple, found directly by experiment, varies between ·69 and ·80 of a volt.

If the values found experimentally differ from that indicated by theory, it is owing to the fact that the electromotive force, or more correctly, the energy transmissible to the circuit of couples with a single liquid, varies not only with the nature of the positive electrode (inactive metal or carbon), but also according to its physical condition, and this explains why different values of the electromotive force of these couples have been found by the various experimentalists who have endeavoured to determine it, as is shown in the following table:—

Electromotive Force of Couples with a Single Liquid ($SO_4\ H_2\ Ag$).

	Electromotive force. Maximum.	Minimum.
Zinc-platinum (? platinised zinc) ...	1·56 volts	·71 volt
Zinc-platinum...	1·41 „	·60 „
Zinc-carbon	1·38 „	·83 „
Zinc-copper	·96 „	·88 „

I found for the zinc-carbon couple with dilute sulphuric acid the following electromotive forces:— §

At the beginning...	1·37 volts
After some minutes	1·00 „
After some hours...	·83 „

It follows, then, from the principle already stated, that if the chemical energy produced in couples with a single liquid is always the same whatever may be the acid used, and that it only depends on the metal attacked, the energy transmissible to the circuit, under the form of electric current, varies, on the contrary, with the nature and condition of the substance constituting the positive electrode of the battery. I will remind my readers, with regard to this, that I showed some time ago, that the electromotive force of the same couple varies according to the nature of its positive electrode. In fact, a magnesium-platinum couple with dilute sulphuric acid, should, according to thermic data, decompose water, since the heat given off by the action of the magnesium on the dilute sulphuric acid (112·8 cal.) is greater than the heat of decomposition of water (69 cal.)

However, the decomposition of water does not take place.

It is the same if we substitute for the platinum of the magnesium battery, copper or silver, but if we use a cylinder of graphite or retort carbon, electrolysis takes place.

According to Gore the electromotive force of the magnesium-platinum couple with dilute sulphuric acid is 1·92 volts corresponding to 88·8 cal., and consequently far above the heat of formation of water (69 cal.), and yet, as we have just seen, the water is not decomposed. Now, it has always been assumed that there is equivalence between the calories transmissible to the circuit and the electromotive force of the voltaic couple. How is it then that there is an exception in the case of the magnesium couple? It is very difficult to explain this anomaly, unless we assume that in this couple there are not only the calories confined in the battery (as Favre has stated) and not transmissible to the circuit, but also among the calories transmissible to the circuit, there are some that would act, if I may so express it, electrically, and some chemically. I cannot now develop this idea further, but I hope soon to return to this important question.

* Traité des Piles Electriques, by Dr. D. Tommasi.

† E.M.F. calculated by the electro-chemical equivalent.

‡ It was formerly thought that reductions of this kind could be explained by assuming a special, I might almost say a mysterious, condition of hydrogen, *the nascent state*. Since 1877 I have shown that hydrogen, at the moment when it leaves any combination, owes its reducing properties not to its nascent state, but to the quantity of heat given off when it is set at liberty. (For further details see Traité de l'Electrochimie, by Dr. D. Tommasi, p. 105.

§ For further details see "Traité des Piles Electriques," by Dr. D. Tommasi, p. 94.

THE UTILISATION OF HIGH FURNACE GASES FOR POWER IN GAS ENGINES.

It would appear that our contemporary, the *Engineer*, has been waiting for some expert of repute to bring before its readers the very high efficiency of the blast furnace as a producer of gas suitable for use in gas engines, rather than take the responsibility of so doing upon its editorial shoulders.

We notice that Mr. Bryan Donkin has adopted the title of "high furnace" to indicate the so well-known blast furnace. We quite agree with the writer of the article in saying that the utilisation of blast furnace—or should we say high furnace—gases to produce power "is one of the most striking developments of modern engineering skill."

In introducing the subject, the assertion that "a third step in the development of these engines, and one which bids fair to rival the others in importance, has been made within the last few years," would lead one to suppose that the credit for this development was due to some individual, but at this point the credit is withheld. Who found out that "furnaces for the production of pig iron form, in fact, ideal gas generators?" A little further on it is asserted that a saving of 50 per cent. can be effected by using this gas in gas engines instead of burning it under boilers in the usual manner. This appears to us a very guarded assertion when taken in connection with statements which have frequently been published of late, viz, that under boilers about 600 to 700 cubic feet of the gas is required to produce the power which 100 to 130 cubic feet will give when employed in internal combustion engines. If the gain to be obtained were only 50 per cent., then the conservatism of British ironmasters would be very reasonable.

In referring to the available gas for power purposes, Mr. Donkin would appear to consider that the amount of leakage in the pipes is considerable, for he says, "With full deductions for leakage in the pipes and for the necessary purposes of the furnace, viz., for heating the air blast and working the blowing engines, it has been calculated that at least 60 per cent. in volume of the gases would thus remain over to be utilised as power."

In this connection it may be mentioned that the leakage in the pipes is not at all considerable, and is so objectionable and poisonous that it is prevented by all possible means, whatever the loss from the top of the furnace may be, and we think that blast furnace managers will be surprised to learn that, including waste, only 40 per cent. of the gases are necessary to provide the heat of the blast and raise steam for the blowing engines, &c.; but if the figures are reversed there still remains an enormous amount of power available for any purposes to which it can be applied by means of suitable gas engines.

Large gas holders are not generally advocated, as other means can be preferably employed, such as a combined blower and exhauster for propelling the gas to the engine.

There is little doubt that the chief difficulty in the application of blast furnace gas to gas engines is the amount of fine dust carried along in suspension. Though a small engine may be run for a considerable period with the gases as they leave the ordinary dust catchers in common use with furnace plants, when larger engines are considered this arrangement cannot be satisfactory. It is practically admitted, by those who have made the experiment, that the gases must be freed almost entirely from suspended matter.

That British ironmasters have not made much progress in the matter of utilising their spare gases is probably due to the fact that gas-engine makers have not been in a position to meet the sudden demand for large gas engines, owing to the activity of the trade at the time when it was realised that it was possible to harness this large source of power.

Whether the idea of utilising these gases originated almost simultaneously in several countries, may be open to question, as nothing was done in this direction in any foreign country before 1895, whereas Mr. B. H. Thwaite's patent bears the date of 1894, and was published in 1895. That people on the Continent can claim ignorance of British enterprise seems strange when the *Iron and Coal Trades Review*, and *Le Rappel*, in France, had leading articles on the subject in 1895, and under the circumstances, we are surprised that more credit is not given to Mr. Thwaite, seeing that he filed the first patent of importance in 1894, or about a year in advance of any experiments on the Continent.

Where success has been attained on the Continent, the result has been achieved by a firm making the experiment and doing the work at its own expense; when it has overcome the difficulties and made the installation a success, the firm is quite ready to place orders for still larger engines, owing to the fact that the economy is so promising.

In the Oeckelhaeuser engine, illustrated in the article in the *Engineer*, there are many points which hardly commend its adoption in preference to the twin cylinder engine. To render it a two-cycle engine

has necessitated a considerable amount of complication; there are three cranks as against two in the twin cylinder type, while in each case the frequency of the explosions is the same. The elongated cylinder and the air pump cause the engine to cover a considerable length of floor space, not to speak of the "disadvantages of the crosshead slides connecting rods, &c."

In Mr. Bryan Donkin's remarks about this engine he says:—"It is *said* to yield four times as much work as a four-cycle for same piston diameter, and the same speed."

"In the near future this engine *may* possibly have a considerable development."

"The governor is *supposed* to act simultaneously."

"The cooling jacket *appears* to work well."

"In the Oeckelhaeuser, these evils of overheating are *said* to be avoided." From which we gather that he has hardly confidence in the statements himself, and would prefer that they should be confirmed.

The tests made by Prof. Witz are very interesting and instructive, but the results have been before the public ever since they were made, in more or less complete form, and cannot now be considered up to date, the following papers being amongst those which have referred to the above test at Seraing:—*The American Manufacturer*, November 4th, 1898; *Science and Art of Mining*, September 21st, 1898; *English Mechanic*, December 2nd, 1898; *Journal of Gas Lighting*, November 15th, 1898; *Electrical World*, October 29th, 1898; *Mechanical World*, December 8th, 1898.

THE ELECTRIC LIGHTING OF AN HOTEL.

There are numerous isolated electrical plants running in English hotels, which possess features of interest. We suppose that first in importance there stands out the extensive installation in service at the Hotel Cecil. It would seem that hotels generally afford a very satisfactory field for realising the advantages and economies which are considered to result from generating one's own current, as against its purchase from a supply company or a municipality.

In our issue of December 15th we referred to some excellent results which had been secured from the use of private plants in a hundred buildings of various descriptions in America. These results showed up well for separate plants, and we have no doubt that some of the larger hotels, stores, &c., in this country would, as in the case of the Blackpool Theatre Gardens installation, be equally satisfactory. The hotel proprietor may inexpensively safeguard himself against likelihood of breakdown, for in accordance with the present interpretation of electric lighting legislation he is permitted to be connected with the mains of the municipality or the company, as the case may be, whether he takes a continuous or only a "fits and starts" supply, according to the condition of his own plant. Of course the supply authority feels the injustice of such a state of things being possible, as were it to be perpetually prepared to have its supply abnormally increased without a moment's notice, there must be a perpetual expense above and beyond what is necessary under normal conditions. On the other hand, if the supply works have not stand-by plant sufficient for the purpose, the sudden demand is likely to cause some inconvenience to the general supply.

We do not propose at the moment to go generally into the details of hotel installations, but simply to describe an interesting plant which was placed in position in June last at the Atlantic Hotel, Newquay, Cornwall. The hotel is situated in a unique position on the Headland, overlooking the sea from every window.

The engine house, which contains the electrical installation, is about 200 yards away from the hotel; an exterior view is given in fig. 1. From the plant there installed current is obtained for supplying about 300 lamps ranging from 5 to 32 c.p., a five-passenger lift, and a pump. The work was carried out by Mr. F. H. Headley (late Headley and Wilson), of St. Austell, to his own specification.

There are two Campbell 15-h.p. oil engines (fig. 2). The oil is stored in a 1,500 gallon tank, and feeds the engines by gravitation. They drive by Hendry's laminated leather belting, two Wilson shunt wound dynamos, shown in fig. 3 (70 amperes 110 volts, or 50 amperes at 145 volts).

The switchboard has a panel for each dynamo, arranged for coupling either singly or in parallel, either for charging battery or working direct, independently or in parallel. Each dynamo is fitted with a sensitive minimum automatic switch, as well as a 1.75 per cent. shunt regulating switch, and a three-

Fig. 1.

Fig. 2.

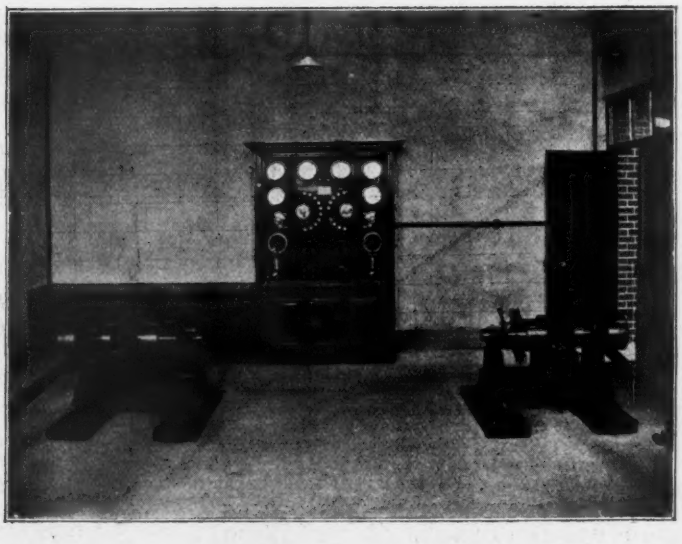


Fig. 3.

way starting switch; by means of the latter the dynamos are made to start their respective engines, the first explosion of which immediately releases the automatic. The dynamo is then again connected up in the usual way. The governor and feed of engine is never altered, the starting, regulating and stopping being entirely controlled at the board, except the final act of turning off oil. The switchboard was designed by Mr. Headley, and manufactured, together with the dynamos and motors, under his late partner, Mr. W. H. Wilson.

The exhaust from the engines is carried in stoneware pipes about 250 yards to the top of the hotel where it causes no nuisance.

The battery consists of 55 D.P. 16-plate cells.

There are two mains from the engine house to the hotel, B.I.W. 19/12 and 19/16 concentric armoured and laid direct. The supply is controlled by D.P. switches and cut-outs on the board. The mains are

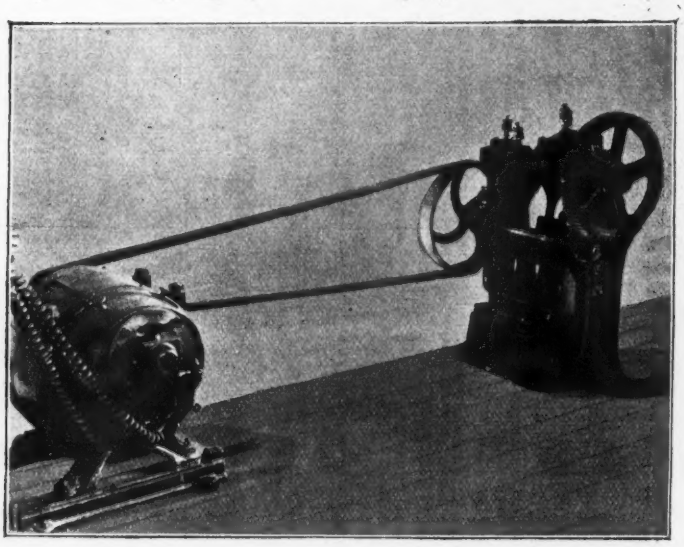


Fig. 4.

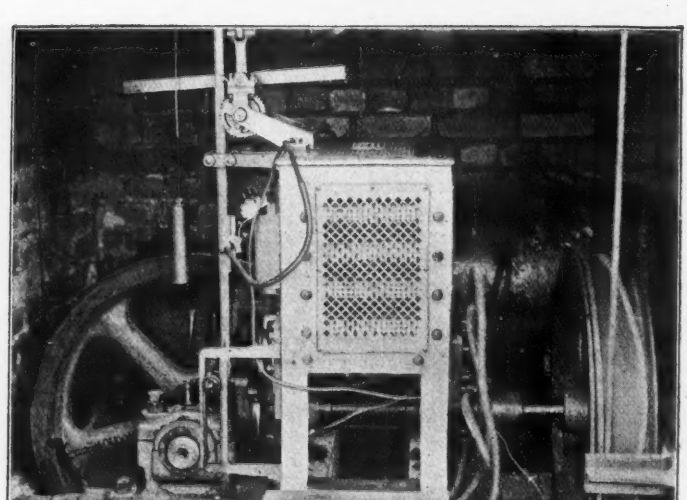


Fig. 5.

connected to another board in the hotel, containing switch gear for connecting the first for lighting only, the latter for power, or *vice versâ*, or in parallel. Each floor's supply is also controlled at this point, whilst the servants' floor is controlled from the manager's room.

The passenger lift machinery (fig. 5) is situated at the top of the well; it was sub-contracted for by Messrs. Waygood & Co.

The three-throw Blake & Knowles plunger pump (fig. 4) forces about 1,000 gallons of water per hour to the top of the roof, the tank being also situated on the top of the lift well. This pump is driven by a 1 H.P. Wilson enclosed motor (made by Messrs. Headley & Wilson, together with the switch gear). This motor is started and stopped by an automatic switch, according to the quantity of water in the tank.

Naturally the time of heaviest load is in August and September, when either the two dynamos, or one dynamo and the accumulators are equal to requirements. Thus the plant is duplicated.

REVIEWS.

The Drawing Office. By C. E. Hodgkin. Reprinted from the *Practical Engineer*.

This unpretentious little pamphlet, which embodies a paper read before the Engineering Society formed by the employés of the Brush Company, is primarily intended for the benefit of pupils and junior draughtsmen, but contains a great deal of instruction of value to more experienced designers. The treatment of the subject is thoroughly practical, and many valuable wrinkles are given in simple wording. The author rightly condemns those draughtsmen "who live for the drawing alone," and would rather pass a poor design than spoil their pretty picture by making alterations; while he applauds the *rara avis* who has learnt that bitter lesson, that the excellence of the design is the only consideration, and that the mere drawing is of no consequence whatever. "Note-book" men, who are lost when they are called upon to take in hand anything original, are referred to, and the learner is advised to depend on first principles instead of voluminous notes. Of especial importance, however, is the author's recommendation to record examples of *failure*, the causes thereof, and the cure. His contemptuous reference to "the crawlers who do as little as possible, and think more of exhibiting their chronometric properties at the end of the day than of the firm's welfare," ought to be posted up in every drawing office. The author deals with the questions of profit, pattern-making, founding, machining, proportions and strength, suitability, provision for wear, expansion, form, nomenclature, dimensioning, standardising, &c., with illustrations, and has something useful to say on each. We note especially the following:—"The Americans do very little fitting, and by their good design and good machinery, have been enabled to modify the operation to 'assembling.'"—There was an epidemic of hot bearings which baffled everyone, till at last it occurred to someone to try reducing the diameter of the shafts—with entire success.

The only fault that we can find is that the author says he wrote the paper for embryos. We trust he meant tyros.

Electric Wiring, Fittings, Switches, and Lamps. By W. Perren Maycock, M.I.E.E. London: Whittaker & Co. 1899.

While this book is suitable for candidates for the preliminary and ordinary examinations of the City and Guilds of London Institute, the author hopes that it will be useful also to engineers, contractors, wiremen, and others engaged in practical work. We have read it with pleasure and profit. We have rarely met with a book which more fully bore out its title and preface, while the treatment of the subject is simple, clear and thorough. We have often thought that some of the wonderfully comprehensive catalogues issued by our large supply firms were really valuable as text-books, and have recommended learners to study them; the present work, while of necessity embodying some of the features of a catalogue, goes much further, providing impartial criticism, explanations, and diagrams of connections. Curiously enough, the subjects occur in exactly the opposite order to that of the title; glow lamps of all kinds are first dealt with in detail, then arc lamps are treated very fully, and with capital figures. Innumerable types of switches and fuses, large and small, are illustrated and described, but we miss the "Nevile" automatic switch, one of the best. The better known systems of wiring buildings are next clearly explained, with numerous figures, and are followed by a capital treatise on *effective*

electric lighting, or the art of disposing and shading the lamps to the best advantage. The book concludes with a section dealing with the calculations involved in ordinary wiring, &c., and a table showing the "lamp-density per head of population" in British cities and towns.

Misprints are remarkably scarce, especially for a first edition; blocks on pp. 90 and 328 are inverted, and on p. 48 the sign ∞ is substituted for $\propto$. We object to calling a 1,000-watt arc lamp a 1-unit lamp; why is the word "kilowatt" ignored? On p. 157 we read:—"The use of a switch at the end of a flexible cord means that both of the conductors are always 'alive' (unless the circuit is cut out), and there is some slight risk of a fire breaking out at an inopportune moment." As the lamp is in series with the hypothetical fault referred to, the risk is, in our opinion, *very* slight—and we wonder what the author would consider an *opportune* moment for a fire!

The expression "different degrees of positive action," p. 181, strikes us as objectionable; either an action is positive, or it is not. For example, a sunk or a flat key gives positive action, a saddle key does not, and there is no intermediate stage. On p. 365 the practice of stranding fuse wires is mentioned, but it is not pointed out that if this is done the strand will melt with less current than the sum of the currents required to fuse the wires separately. We regret that in the index references are given to paragraphs only, instead of to pages; this is a defect which we hope to see rectified in a later edition.

The faults that we have pointed out are trifling compared with the value of the book as a whole, which we cordially recommend both to students and to those engaged in electric lighting work.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1899.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

24,567. "Improvements in controlling apparatus for electric lifts and other electric machines." J. S. Stevens, C. G. Major, E. C. Stevens, and P. H. Stevens. Dated December 11th.

24,594. "Improvements in or connected with automatic electrical cut-outs." F. E. Greenstreet and E. J. Selby. Dated December 11th.

24,614. "Improvements in telephone system and apparatus." E. E. Ries. Dated December 11th. (Complete.)

24,624. "Improvements in and relating to perforators for use in connection with automatic telegraph transmitters." A. Fraser, W. Judd, and G. Draper. Dated December 11th.

24,634. "Improvements in apparatus for electrically lighting railway carriages, and other vehicles." C. A. Vicarino. Dated December 11th.

24,639. "Improved electric top for gyroscopes and the like." W. P. Thompson. (Berliner Maschinenbau Actien Gesellschaft vormals L. Schwartzkopff, Germany.) Dated December 11th. (Complete.)

24,641. "Improvements in the manufacture of accumulator batteries and in porous cells, plates or diaphragms for the same or other batteries and for other purposes chemical or mechanical where an extremely porous or hard material is required." W. W. Pilkington and W. R. Ormandy. Dated December 11th.

24,643. "Improvements in magnet frames for dynamo-electric machines and motors." J. Burke. Dated December 11th. (Complete.)

24,645. "Automatic load starting apparatus applicable to synchronous alternating current motors." C. L. Rosengvist, A. Bergtheil, and H. W. Young. Dated December 11th.

24,646. "Improved apparatus for effecting locked step-by-step rotary motion from a reciprocating motion especially applicable to counting trains." Evershed & Vignoles, Limited, and S. Evershed. Dated December 11th. (Complete.)

24,666. "A method of, and apparatus for the regulation of electric potential in alternating current transformers applicable also to 'boosters.'" F. Hamer. Dated December 12th.

24,668. "Improvements in or relating to means to be employed in connection with the electro-deposition of metals upon iron and steel." H. M. Punnett, and H. M. Punnett. Dated December 12th.

24,669. "Improvements in roller gearing and transmission dynamometers." T. Foster. Dated December 12th.

24,678. "Improvements in electric clocks." J. Butcher. Dated December 12th. (Complete.)

24,701. "An improvement in the manufacture of submarine electric conductors." Siemens Bros. & Co., and W. Dieselhorst. Dated December 12th.

24,717. "Improvements in fire alarm telegraph apparatus." B. J. B. Mills. (The Gamewell Fire Alarm Telegraph Company, United States.) Dated December 12th. (Complete.)

24,718. "Improvements in telephone systems and apparatus." J. E. Kingsbury. (The Western Electric Company, United States.) Dated December 12th.

24,723. "Improvements in the process of smelting ore and in electric furnaces therefor." F. E. Hatch. Dated December 12th. (Complete.)

24,739. "Improvements in or relating to electric switches." W. Ely. Dated December 12th. (Complete.)

24,740. "Improvements in or relating to electric switches." W. Ely. Dated December 12th. (Complete.)

24,760. "Improvements in electrolytic meters." E. Cross. Dated December 13th.

24,780. "Safey trolley head guard for electric tramcars, &c." G. T. Moore. Dated December 13th.

24,791. "Improvements in or connected with electrical traction." W. Kingsland. Dated December 13th.

24,792. "A new and improved method of, and means for carrying and connecting strikers to motor vehicles for mechanically operating electric switches." W. Kingsland. Dated December 13th.

24,799. "A new or improved method of measuring the difference of electric pressure between points of a circuit which may be distant from the observer, and apparatus therefor." M. B. Field. Dated December 13th.

24,805. "Improvements in appliances for reversing the current in continuous current dynamos." Siemens Bros. & Co., Limited. (Siemens & Halske, Aktien Gesellschaft, Germany.) Dated December 13th.

24,824. "Improvements in electric incandescent lamps." C. Howard. Dated December 13th. (Complete.)

24,882. "An improved method of making commutators for electrical machines." F. Kaefferle. Dated December 13th. (Complete.)

24,876. "Improvements in and in apparatus for the manufacture of mangano calcium carbide without the use of electric current." W. P. Thompson. (P. P. H. Mace, France.) Dated December 14th.

24,887. "Improvement relating to electric arc lamps." T. J. Digby. Dated December 14th.

24,898. "Improvements in electric time switches." A. J. Howard. Dated December 15th.

24,914. "Improvements in trolley electric tramways." J. W. Taylor. Dated December 15th.

24,916. "An improved mouthpiece for use with telephonic transmitters." A. Eckstein and A. Brooker. Dated December 15th.

24,940. "Improvements in auto motor trolleys for electrically-driven vehicles." L. L. Gerin. Dated December 15th. (Complete.)

24,942. "Improvements in electric brakes." E. M. Tingley. Dated December 15th. (Date applied for under Patents, &c., Act, 1883, Section 103, May 18th, 1899, being date of application in United States.)

24,956. "Rotary field-measuring apparatus for uniformly loaded rotary phase current systems." (Siemens & Halske, Aktien Gesellschaft, Germany.) Siemens Bros. & Co., Limited. Dated December 15th. (Complete.)

24,960. "A method of producing electrodes for electrical accumulators." C. Luckow. Dated December 15th.

24,965. "Improvements in electric locomotives." B. Hopkinson. Dated December 16th.

24,968. "Process for the production of thermo-electric batteries." B. Jonas. Dated December 16th.

24,970. "Improvements in electric hair brushes." C. R. Schmutz. Dated December 16th. (Complete.)

24,978. "An improvement in or applicable to the filaments of incandescent electric lamps." W. Morton. Dated December 16th.

25,011. "An improved primary electric battery." W. P. Thompson. (J. P. Fontaine, France.) Dated 16th. (Complete.)

25,012. "Improvements in electric accumulators." W. P. Thompson. (G. Daseking and A. Brandes, Germany.) Dated December 16th.

25,019. "An improvement in safety fuses for electrical circuits." Siemens Bros. & Co., Limited. (Siemens & Halske Aktien Gesellschaft, Germany. Dated December 16th. (Complete.)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1897.

5,479. "Improvements in and connected with dynamo-electric machines." C. H. Wade and H. O. Farrell. Dated March 2nd, 1897. For the purpose of obtaining a practically constant voltage from dynamos driven at variable speeds, the field magnet is wound with a main or energising coil and a subsidiary coil acting in opposition thereto. The subsidiary coil is divided into sections, which are connected to the terminals of a switch, operated either by hand or automatically, such as by a centrifugal or other governor. When the machine is run at constant speed, the apparatus may be used to control the output. 2 claims.

6,197. "Improvements in or relating to electric apparatus for governing engines." J. Snow and A. G. Cooper. Dated March 9th, 1897. Relates to the governing of an engine driving a dynamo, and consists in an arrangement of electro-magnetic devices, operating in conjunction with a centrifugal governor to control the expansion gear of the engine so as to adjust the steam supply to the requirements of the external circuit. The solenoid acting on the core attached to the lever through which the adjustment of the expansion gear is effected, is arranged either in the main circuit of the dynamo or in a shunt circuit. The latter is in practice adopted by preference. The current in the circuit is varied in accordance with variations in the potential difference of the dynamo by the automatic regulation of resistances in a shunt containing a solenoid, acting against an adjustable spring. The application of the invention to a shaft governor is also shown in the specification. In this form of the invention the solenoid is mounted on the governor disc, the circuit being completed by means of brushes. 3 claims.

6,212. "Improved means for supplying electric current to electrically-operated time keeping mechanism." A. W. Staveley, J. H. Parsons and T. J. Murday. Dated March 9th, 1897. A roller on a pendulum lifts a bevelled horizontal lever, so making a pawl which hangs from the lever drive a ratchet wheel, the arbor of which bears the minute hand. The energy of the pendulum is maintained by an electro-magnet, the resilient arm of which bears a hook engaging the pendulum rod. Normally the circuit is broken by a gap between two strip terminals, and a loose finger upon the pendulum is drawn to and fro over a block on the upper terminal. When the oscillation becomes so reduced that the finger does not leave the block, the terminal is thrust against its fellow and the current passes. In a modification, instead of the pendulum, there is a balance driving the hands by means of an anchor propelment. 3 claims.

6,309. "Improvements in calling-off apparatus for telephone exchanges." Siemens Bros. & Co., Limited. (Siemens & Halske.) Dated March 10th, 1897. Calling-off signals for telephone exchanges are sent by reverse currents from the subscriber's magneto-generator, which produce a visible signal in a polarised indicator. The signal is either sent by hand or automatically by means of a coiled spring, which is set by sending the ringing-up signal. In one arrangement is the generator crank, the axle of which carries a wheel gearing with a wheel on the same axle as a ratchet wheel. A spring pawl on a spring-controlled lever engages with the ratchet wheel, and so turns the lever when the ringing-up signal is sent that the heel engages above a spur on a spring lever. The telephone lever is provided with an extension which releases the levers, thus sending the calling-off signal when the telephone is placed on the hook. In a modified form, a drum spring is used, a tripping pawl being released by the telephone lever. 4 claims.

6,774. "Method and appliances for brazing or soldering by electricity." W. C. Johnston. Dated March 15th, 1897. Tubes, cycle and motor car frames, tubes, and tube plates for boilers or condensers, and tubular articles are joined by interposing a layer of soldering or brazing metal between the surfaces to be united, and then passing an electric current either longitudinally or transversely through the two articles to be joined. The soldering or brazing metal is in the form of a sleeve or a gauze or spiral of wire. The wires may be of different degrees of fusibility, and some of the wires may remain unmelted and form

distance pieces between the objects to be united. The built up frame with the brazing metal interposed in the joints is held in clamps or supports on a slate, &c., bed. The conductors for the current are connected to the frame by terminals. 5 claims.

6,929. "Improvements in apparatus for electrolysing sodium chloride or other salts." F. Taylor, A. Cooke and B. W. D. Montgomery. Dated March 17th, 1897. Relates to apparatus for electrolysing sodium chloride or other solution and for absorbing the evolved chlorine. The vat contains a number of iron sheets or cathodes alternating with vertical rows of carbon rods or anodes. Each anode and cathode is supported in a frame which also supports on each side of the electrode glass or other strips arranged louvre fashion. The upper part of each anode has an inverted trough to collect the evolved chlorine and direct it through tubes. The caustic soda or like body formed at the cathode falls to a bottom trough, and is led away therefrom. To prevent polarisation air may be injected below each anode, or the electrolyte can be kept agitated by injecting it in an intermittent or pulsating manner. The evolved chlorine is absorbed in a vessel charged with water and lime or magnesia, the gas entering from the tube to a rotating tube provided with hollow distributing arms. 2 claims.

6,962. "Certain improvements in electro-plating apparatus." J. Guise. Dated March 17th 1897. Relates to apparatus for electro-plating with nickel or other metal small articles such as knitting-pins, crotchet-hooks, and small parts of bicycles. Consists of a watertight wood barrel having one removable end which is secured by bolts and fly nuts, a rubber or like band making a watertight joi. The articles and electrolyte having been placed in the barrel, the latter is mounted by its divided axle upon standards. A spirally-wound wire joined by cross wires is secured around the inside of the barrel and is connected to an external metal ring connected by a brush to the cathode wire from the dynamo, &c., while insulated nickel or other discs are connected either directly by the axle or indirectly by the insulated wires to a brush connected to the other pole. A canvas or like screen may be inserted near each end of the barrel to prevent the articles from touching the anodes. The barrel is rotated by an suitable means, such as by a pulley, whereby the articles are polished during position. 2 claims.

7,012. "Improvements in supplying electrical energy to electrically-propelled aerial machines and balloons." R. Diesel. Dated March 17th, 1897. To enable the cable supplying electricity from the ground to the electrically-propelled aerial machines to become longer or shorter as the machine is swayed by the wind, it is coiled on a drum at one end, which is constantly tending to wind it up. The drum may be turned by an electromotor which is reversed by the pull of the cable when it becomes excessive, or the drum may be driven through a clutch which is thrown out of gear by an excessive pull on the cable, and into gear by a spring when the pull is diminished. 1 claim.

7,027. "Improvements in and relating to secondary batteries or accumulators and the manufacture thereof." A. J. Marquand. Dated March 17th, 1897. Electrodes or plates are made by heating lead grids, frames or foundations, in a closed box with sulphur to the melting point of lead, so as to cause the formation of lead sulphide on the surface of the plate. The conducting strips and supports of the lead frame are protected from the sulphur preferably by coating them with an enamel composed of calcium fluoride, felspar, sodium silicate, silicon dioxide, and barium sulphate. The plate thus formed is converted into a negative plate by electrolysis in a solution of dilute sulphuric acid, and fr the negative plates positive plates are formed by electrolytically peroxidisi on. The liquid in which the lead sulphide plates are reduced is used as a lectrolyte in secondary batteries, or a similar liquid for the same purpos y be formed by adding thionic acids or their salts to dilute sulphuric acid. In a modification, the lead grid is packed with a paste consisting of lead sulphide or a mixture of lead or lead oxides with sulphur, and this is heated and then electrolytically formed in the usual way. 5 claims.

7,212. "An improved rheostatic apparatus particularly applicable to the starting of electro-motors." G. E. Dixon. Dated March 19th, 1897. Resistance coils, wires, or strips, which may be of iron or German silver, are embedded in enamel on the underside of an iron or other metal base as illustrated in section, so that they may be allowed to become hot. Ribs are formed on the base to dissipate heat. The base has hollow feet and carries a row of contact studs connected with different parts of the resistance, and a movable switch arm. The studs and switch pivot are insulated with bushes of heat-resisting material, such as vulcanised fibre. The switch is turned against a buffer by a spring to include all the resistance in circuit, but may be held by a clip at the other end of the line of contacts. The rheostat is particularly applicable for starting electric motors. 3 claims.

7,223. "Improvements in electric sound producing devices." W. P. Thompson. (J. A. G. Trudeau.) Dated March 17th, 1897. Relates to apparatus for producing sound applicable wherever electric bells can be used such as in houses, fire-alarms, and calling or signalling systems. A number of electro-magnets set in a frame are supplied with alternating currents, and act on a magnet plate or diaphragm. A diaphragm may be placed at each end of the magnets, and a bell mouth may be placed in front in case of foghorns. The apparatus is also referred to as a factory, boat, or railway whistle. 3 claims.

7,305. "Improvements in brushes for the commutators of electric dynamos and motors." E. L. Joseph. Dated March 20th, 1897. Brushes are made with copper or other tongues at their upper ends. When a brush is worn so that it is too short for use in the ordinary holder, the tongue is soldered into a corresponding socket on a supplementary bar, and this is used in the holder until the remainder of the brush is worn down. 2 claims.

7,315. "An electric circuit hour-meter or automatic cut-out." C. O. Bastian and F. M. Staunton. Dated March 20th, 1897. On turning a triangular cam after a coin has connected a handle to it, a pivoted fork is dipped into a pair of mercury cups to complete the main circuit, and a disc bearing one terminal of a branch circuit is turned so as to separate this terminal from its fellow on a co-axial crown wheel which is in the same plane as a set of concentric crown wheels driven uniformly. The concentric crown wheels have radii of lengths (relatively), and a sliding cross-shaft, bearing pinions, transmits motion from any one of them according to its position which depends on the number of switches passing current. The switches act on a rack and the displacement of the latter is transmitted through an idle wheel to the slide which carries the cross-shaft. When the terminal on the driven crown wheel has overtaken the terminal on the concentric disc, an electro-magnet in the branch circuit disengages a catch which holds the fork in the mercury cups. 4 claims.

7,412. "An improved switchboard indicator or annunciator." W. H. Holland. Dated March 22nd, 1897. (Date claimed under Patents Act, 1883, Sec. 103, September 5th, 1896, being date of application in the United States.) Indicators or annunciators for telephone switchboards, &c., are arranged with the operating parts on the front of the board, and the magnets secured in an easily removable manner at the back. A plate fixed over an aperture in the board has pivoted to it the armature with the required sign on it. A shutter is in front of the armature and normally kept upright by lugs engaging the armature. The magnet has a T-head which can be inserted in a slot in the plate and secured by a partial turn. A case is passed over the magnet and secured by a groove on it engaging with a segmental-headed screw which is made to release or engage the groove by a half turn. On completing the circuit the armature releases the shutter, pushing it outwards by lugs allowing it to fall and show the sign. A lug on the shutter completes a night-bell circuit in the usual way through a contact when the shutter falls. The armature may have projections at its lower end to enable it to be operated by the finger. 6 claims.

7,421. "Improvements in or connected with the electric lighting of buildings or other areas, particularly applicable to fire brigade stations, asylums, hospitals, hotels, ships, and like institutions." R. F. K. Stubbs. Dated March 22nd, 1897. Relates to the arrangement of circuits in fire brigade stations, hotels, &c., so that all the lights or any desired number of them can be controlled by a single switch placed in any desired position. Instead of having separate "call" lights, a third wire is arranged and connected so as to operate all the lights from one switch, and the switch may be operated by a handle, or may be automatically operated by electro-magnets which are in the bell or alarm circuit. Some of the lights are used for lighting only, others for "call" and for general lighting, while others are for "call" only. 2 claims.

7,462. "Improvements in or connected with the current supply and conduits for electric traction." R. C. Sager. Dated March 23rd, 1897. The conduit is formed by the running rail and a guide bolted to the concrete lower part. The former rail is formed with a deflecting angle to throw water, &c., clear of the conductors. The two rails may be such as only to leave spaces between them at intervals or to leave a continuous slot. The conduit is cleaned by a scraper attached to a chain drawn through by means of sprocket-wheels at the manholes. The collector consists of bars thrust out from an inclined wheel so as to pass into the conduit between the conductors. This wheel is driven from the toothed or flanged running wheel by a universal joint. By means of linkwork and levers these radial bars may be retracted so as to be inoperative. 1 claim.

7,497. "Improvements in regulable transformers, and in regulating alternating current dynamo-electric machines." H. H. Lake. (General Electric Company.) Dated March 23rd, 1897. Relates to a regulable transformer for use in regulating dynamos, motors, &c. Consists of an alternator in which the field-magnet excitation is furnished from the transformer. The transformer has one primary coil in shunt with the mains and is provided with a resistance. The secondary is connected to a rectifying commutator. A third or modifying winding is in series with one of the mains and a resistance is arranged in shunt. The regulation of this resistance enables the effect of the modifying coil to be varied and so regulate the generator. An air gap is left in the magnetic circuit. In dynamos provided with separate exciters the transformer is arranged to regulate the field of the exciter. In the tranformer for the motor the modifying coil has two windings. Resistances are shown. The transformers may be wound for varying the phase-relationships in the different circuits. 11 claims.

7,522. "Improvements in electrically-propelled cars and like vehicles." J. F. McElroy. Dated March 23rd, 1897. Rollers driven by an electromotor are grooved so as to engage the flanges of the wheels and drive them in the same direction. The axle boxes, which can move horizontally, are linked by bars to the arm of the saddle which has springs to support the flanges of the supporting frame on which the car is mounted so as to be capable of rotating. The arm of the saddle is guided by means of springs. The specification describes modifications with respect to the disposition of the friction rollers in all of which the traction is directly proportional to the load carried. 8 claims.

20,919. "Improvements in electric signalling systems, such as fire alarms, telephones, and telegraphs." J. L. Walker and G. B. Walker. Dated September 11th, 1897. Fire or similar alarm systems worked with closed circuits are provided with contact springs at the central station and boxes containing similar springs and signalling instruments at various points. The telephone may be inserted at the central station without breaking the closed circuit, but at the distant station the call is sent by providing the telephone, &c., plug, with an insulating end which breaks the closed circuit before the instruments are connected up. 1 claim.

21,055. "Improvements in and relating to electric cars and surface contact railways." The British Thomson-Houston Company, Limited. (E. M. Howlett.) Dated September 14th, 1897. Electric railways and tramways on a road-contact system with electro-magnetic switches operated from a battery on the vehicle. To reverse the connections of the shoes which rub over the road contacts supplying current and operating the switches respectively when the vehicle is being reversed on the Y-track, and thereby to change the battery connection to the low-potential side, an extra shoe rubs over a grounded contact and thus allows the coil to be excited and to break the battery circuit by the switch. In a modification, the coil is not cut out when the switch is thrown. A double-pole reversing switch is then used to reverse the connections and the switch is restored by hand. In this switch is a blow-out coil. 4 claims.

22,633. "Improvements in or relating to electrical connecting boards." A. Whalley. Dated October 2nd, 1897. Cross-connecting boards for exchanges of telephone systems, &c., are formed preferably of a sheet of material such as ebonite, upon which are marked the positions of the perforations, the dividing lines, and the subscribers' numbers. The contacts are preferably in the form of tubes, but may be solid with the front end axially drilled. The contacts may be secured by expanding, &c., and the back projecting parts are preferably flattened and connected in horizontal pairs. When the board is formed of materials which cannot be moulded, a sheet of ebonite, &c., having the necessary slots is secured to its face. 4 claims.

26,827. "Improvements in electric arc lamps of the enclosed type." A. L. Davies. Dated November 17th, 1897. In an enclosed arc lamp the upper carbon is held between three radial jaws fulcrumed on a loose ring and connected at their outer ends to an electric controlling device, such as three links attached to the tubular core of a series or differentially wound solenoid. The jaws operate through slots in a tube in which the carbon slides, so that when their outer ends are raised the jaws grip and lift the carbon, but, when the outer ends are lowered, the jaws are tilted by contact with the lower ends of the slots and allow the carbon to slip. The movements of the core are controlled by a dash-pot. The solenoid is carried by a tube. The solenoid may be shunt wound, in which case the core is supported above by a spring. A series resistance is wound on a sheet of asbestos surrounding the casing of the mechanism, and is protected by an outer cover. The arc enclosing globe is held against a cover of heat retaining material, such as fireclay or asbestos; this is stated to render the arc stable, so that the outer globe need not be sealed. 5 claims.

26,880. "Improvements in and relating to electrical furnaces, specially applicable for the production of calcium carbide." G. W. B. Crees, W. L. Durban and J. Gore. Dated November 17th, 1897. The two ends of an incandescent furnace, applicable for making calcium carbide, are formed by the electrodes, or by blocks containing the electrodes, so that these two extend to the bottom of the furnace. The electrodes are held by copper or other frames attached to threaded rods which are movable by nuts rotatable by hand wheels in bearings. The electrodes may thus be moved inward to clamp the conducting rod with which an operation is commenced, or to raise the materials after partial conversion. Springs, weighted levers, or other adjusting devices, may be used instead of the screws. The sides of the furnace may be fireclay slabs secured to the bottom by tie bolts. A discharging slide may be provided in the bottom. 1 claim.

26,919. "Improvements in or relating to the application of electrodes in electrolytic process." Dr. O. C. Strecker and Dr. H. H. Strecker. Dated November 17th, 1897. Consists in employing, in electrolysis for the production of oxides and salts in which the anode is to be dissolved, anodes and cathodes of different metals, whereby the tension is considerably reduced. A number of tables of results are given showing the tensions when the same or different metals are employed as anodes and cathodes in a solution of 15 per cent. sodium chlorate, and in one of 26 per cent. sodium chloride. 1 claim.

26,921. "Improved process for preparing insoluble or hardly soluble salts from metallic anodes by electrolysis of aqueous solutions containing two salts." Dr. O. C. Strecker and Dr. H. H. Strecker. Dated November 17th, 1897. Relates to the preparation of salts which are insoluble or only slightly soluble in water or solutions of salts, such as white lead; and consists in forming the electrolyte by mixing two salts, one to dissolve the anode being added so as to produce the greatest conductivity, and the other to precipitate the salt being added in the proportion of the electro-chemical equivalent of the current density employed. For white lead, carbonic acid gas is injected, whereby also the electrolyte is agitated. For other salts the acids withdrawn from the electrolyte are continuously supplied. 1 claim.

26,923. "Improvements in or relating to the production of protoxides and hydroxides from metallic anodes by electrolysis of alkaline salt solutions." Dr. O. C. Strecker and Dr. H. H. Strecker. Dated November 17th, 1897. Relates to the production of electrolysis of insoluble, or only slightly soluble, metallic oxides and hydrates, particulars being given for the preparation of the following oxides or hydrates: Zinc, tin, iron, copper, nickel, cobalt, bismuth, antimony, cadmium, silver, and lead. Consists in employing a solution of an alkaline salt, such as of sodium chloride, chlorate or sulphate, as an electrolyte, with metallic electrodes corresponding with the oxide or hydrate required, and employing a current strength of 0·5 ampere per square decimeter of anode surface. By this arrangement the alkaline salt is decomposed, its acid ion dissolves the anode, and the salt formed is then decomposed by the alkaline hydrate re-forming the alkaline salt and precipitating the required metallic oxide or hydrate. 1 claim.

UNIV. OF MICH.
JAN 8 1900

THE ELECTRICAL REVIEW

VOL. XLV. No. 1,153. [All Rights Reserved.] DECEMBER 29, 1899. [Registered at G.P.O. as a Newspaper.] PRICE FOURPENCE.

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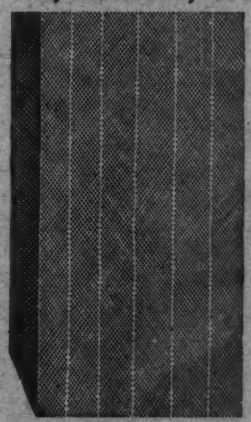

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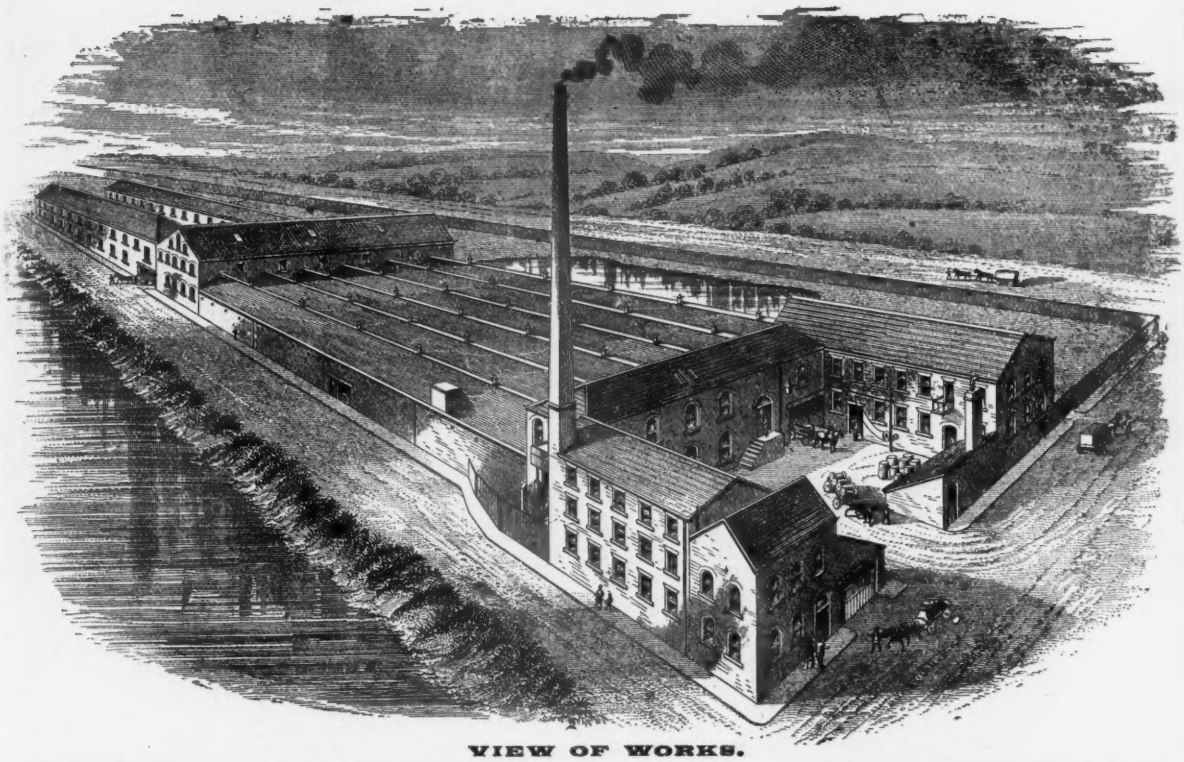

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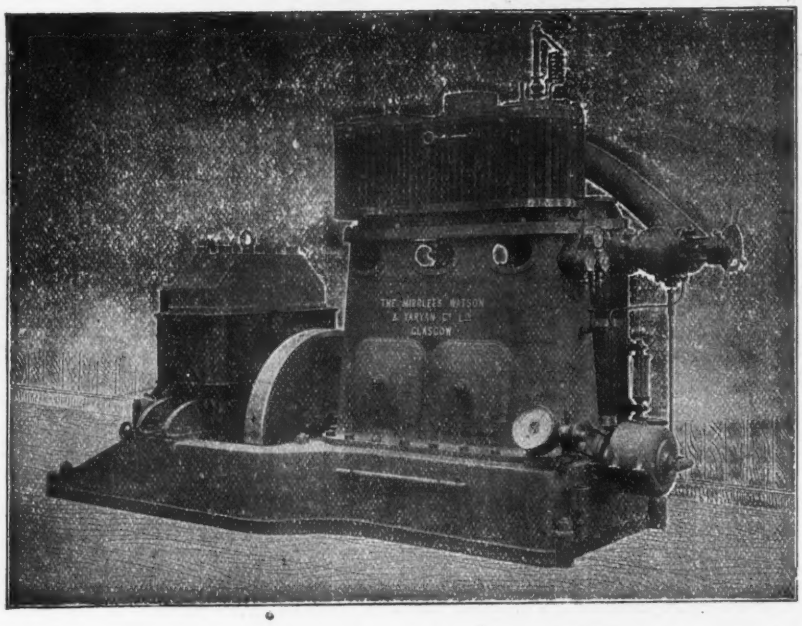

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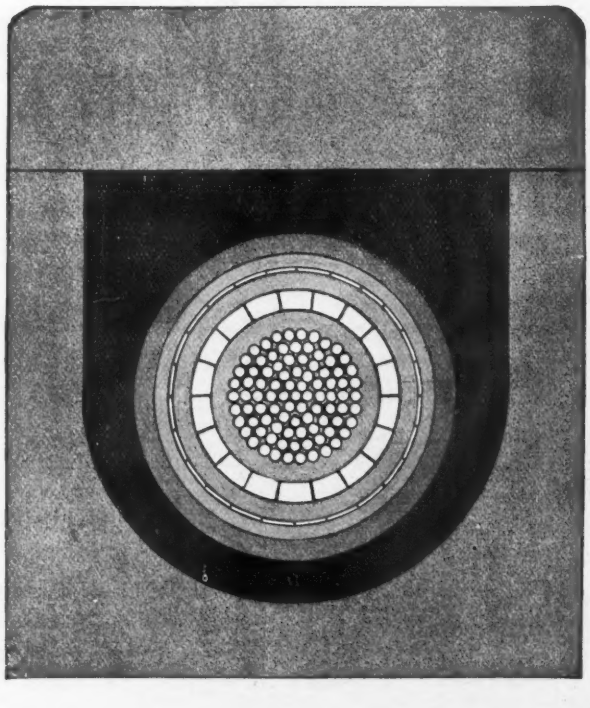

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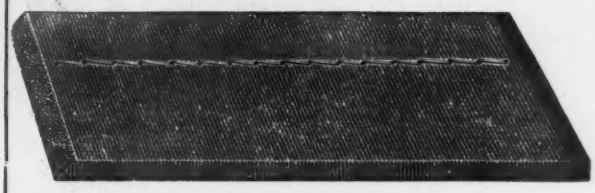

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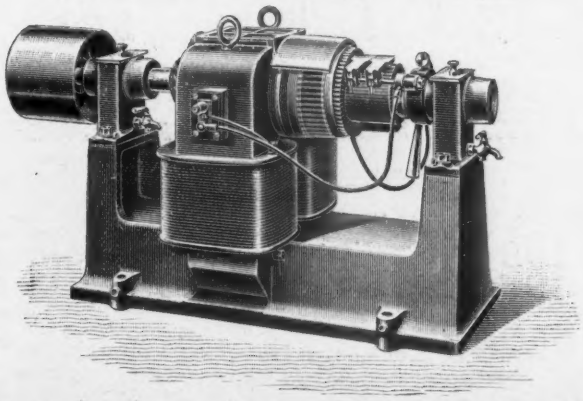

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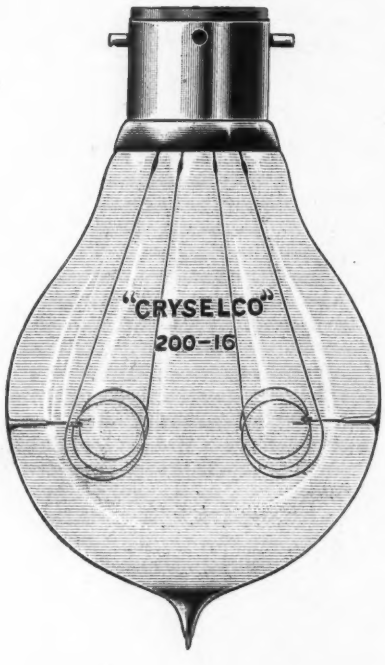

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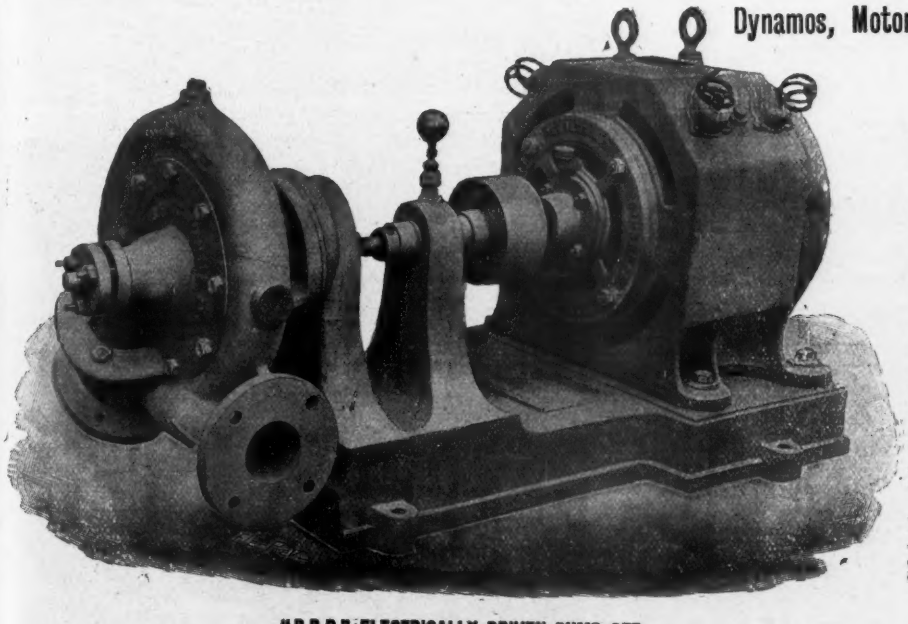

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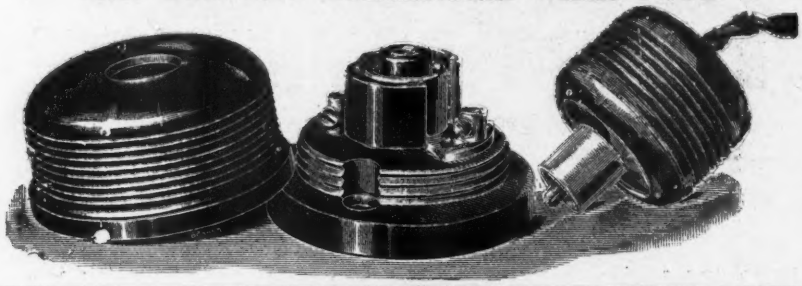

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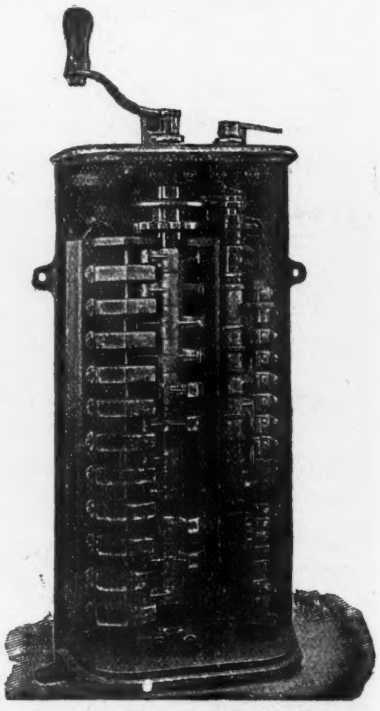

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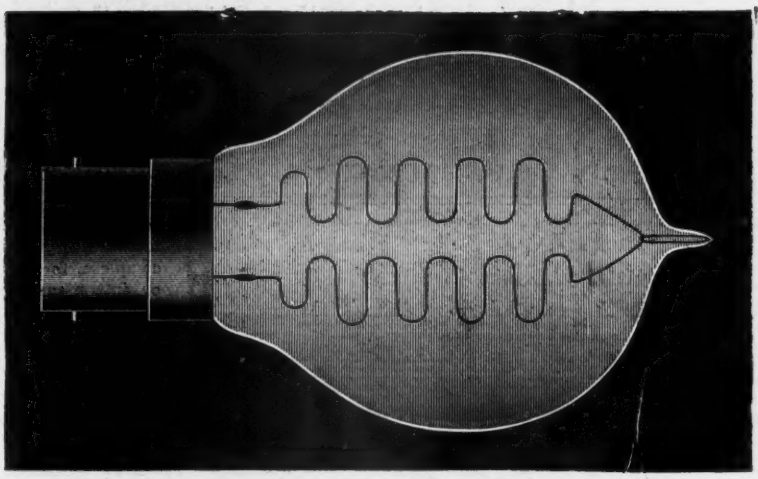

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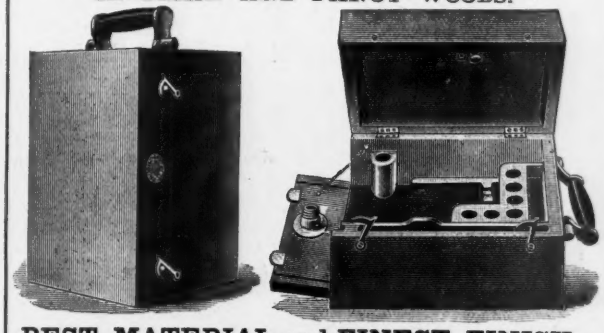

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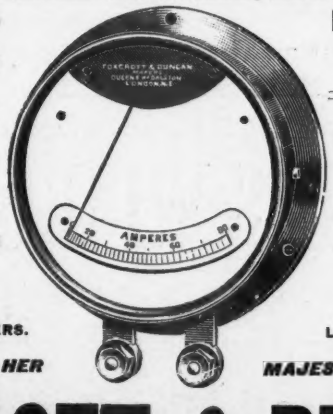

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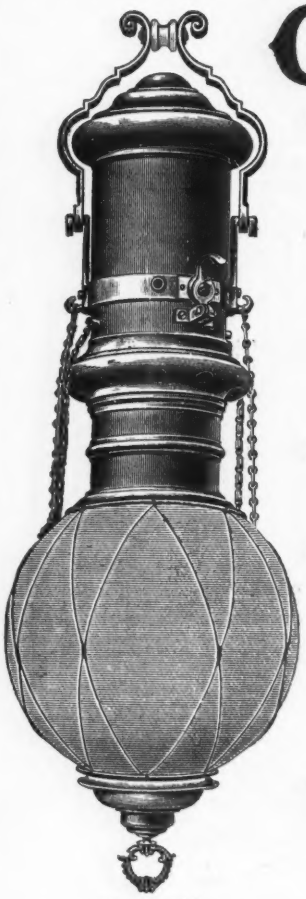

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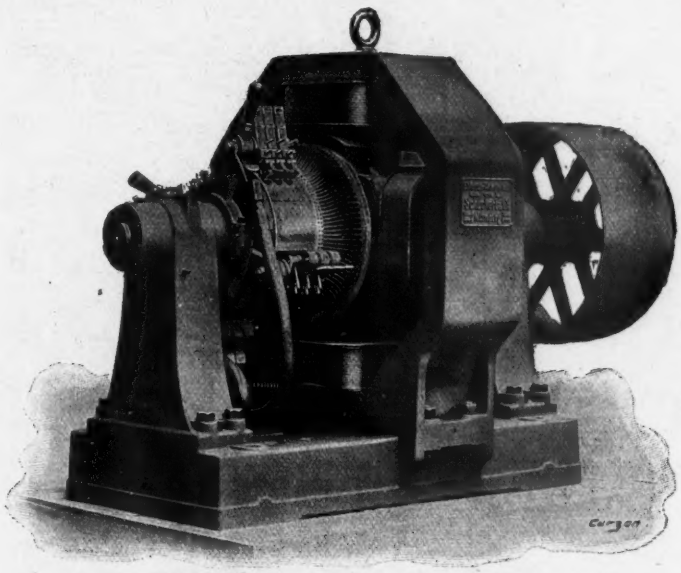

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311·4	5·4	305	35·2	40·2	84·2
312·6	4·6	350	35·4	40·2	83·8
314	4·05	400	35·5	40·2	83·3
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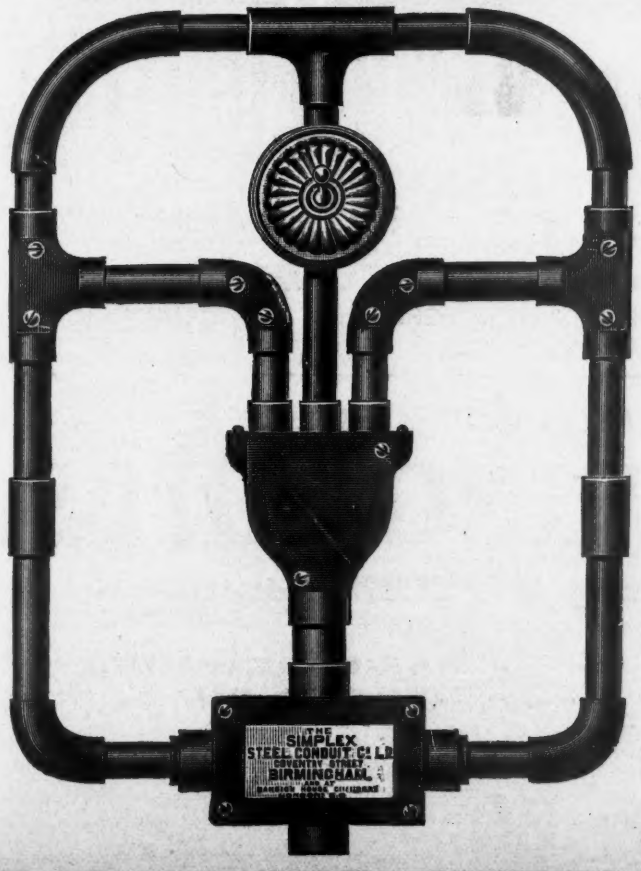

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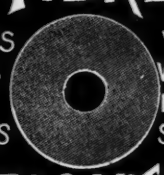

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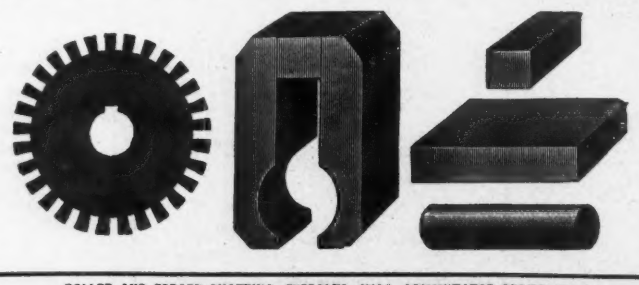

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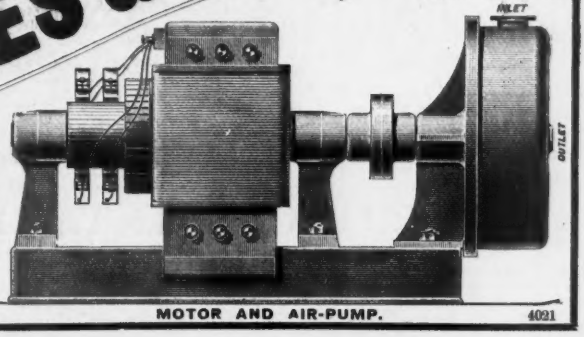

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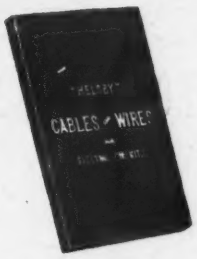

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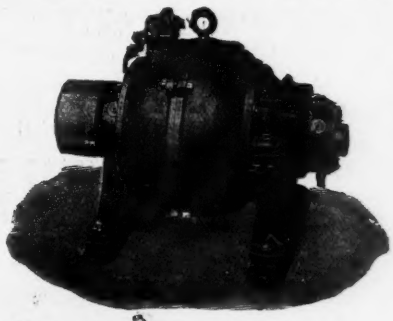

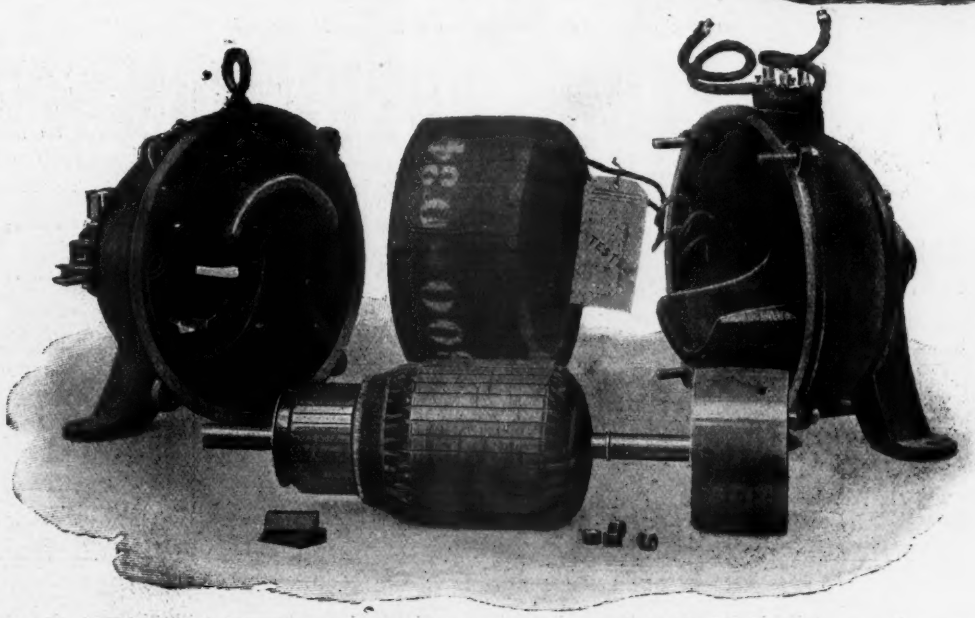

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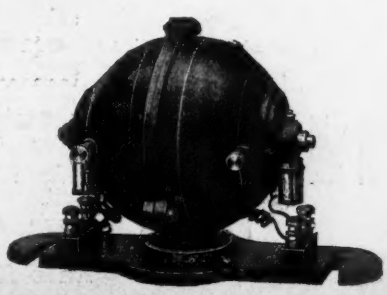

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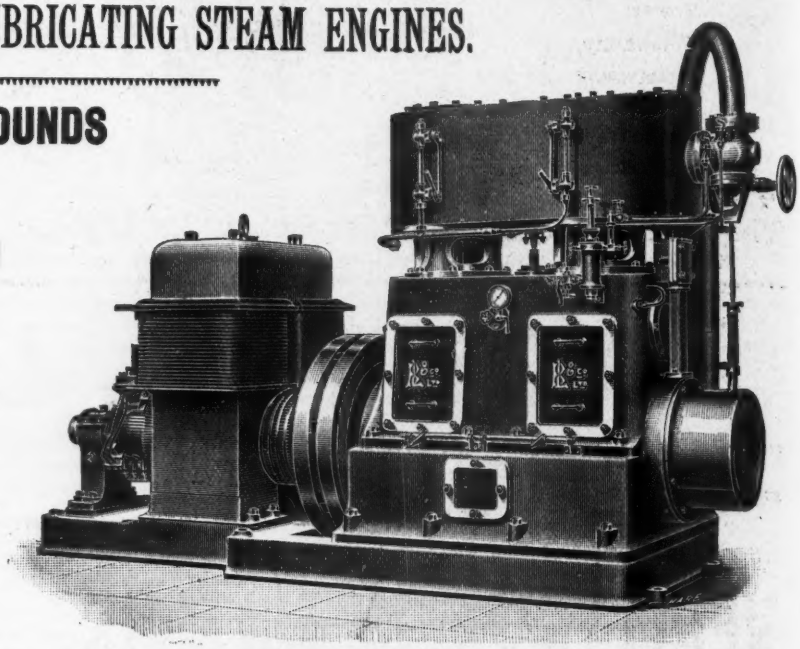


Send Your Enquiries and Specifications to

BROWETT. LINDLEY & CO. (1899), Ltd., PATRICROFT, MANCHESTER.

N.C.S.
NEW PATTERN POTENTIOMETER.

Reads by ten thousanths of a volt up to 1·6 volt direct, and with multiplying powers up to 200 volts. For higher values a known resistance can be added outside and allowed for.

Complete in Polished Ebonite with our Special Standard Cell Key, Multiplying Powers, and adjusting resistances, Price £40.

FOR HIGH AND LOW VOLTS.

D'Arsonval Galvanometer suitable for use with the above, £5. Standard Cell in Case, with Thermometer, £1 15s. Two Cells in Case, with Thermometer. £2 10s.

WRITE FOR CATALOGUE OF TESTING INSTRUMENTS.

NALDER BROS. & CO.,

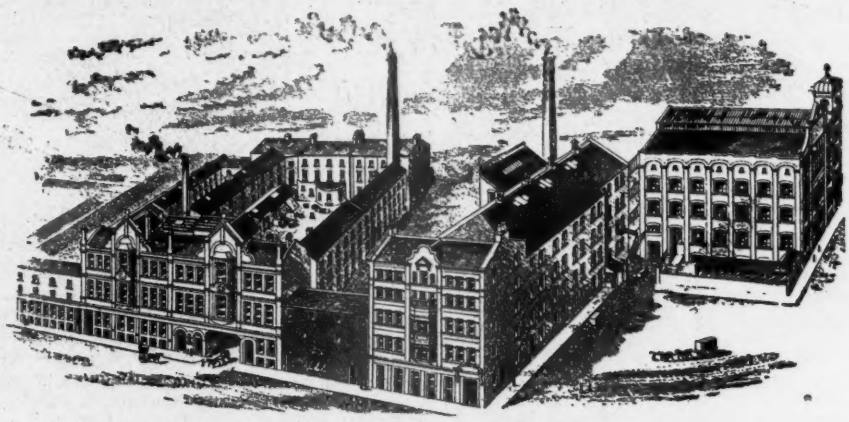
Prince's Mews, Gt. George Street, Westminster, S.W.

Late 16, Red Lion Street, Clerkenwell.

ELECTRIC LIGHT CABLES.

AERIAL. VULCANISED. CONCENTRIC. ARMOURED.

As supplied to Leading Corporations, Engineers, Electric Lighting Companies, and Contractors in the United Kingdom.

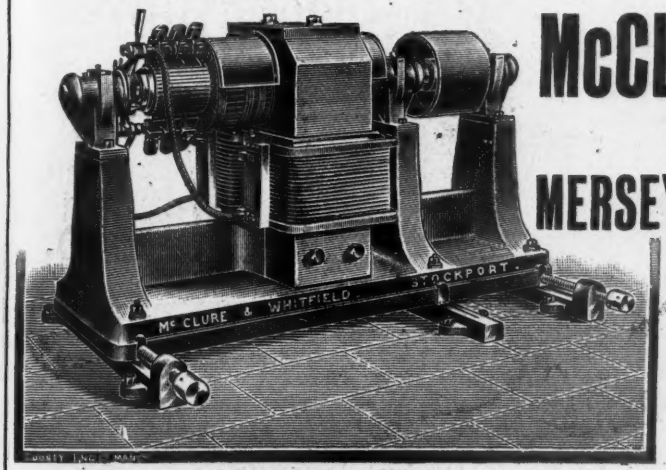


GREENGATE RUBBER AND CABLE WORKS, SALFORD.

I. FRANKENBURG, Manchester.

London Office:—128a, QUEEN VICTORIA STREET, E.C.

NOTE:—Having been *Established over 30 Years* as an India-Rubber Manufacturer, and having supplied Rubber for Cable Purposes for many years, no Firm has greater advantages for the manufacture of India-Rubber Cables and Wires.



30 KILOWATTS AT 110 VOLTS AT 850 REVS.

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MERSEY DYNAMOS AND MOTORS.

DYNAMOS

For Arc and Incandescent Lighting, Transmission of Power, Electro-plating and Depositing, Electrolysis.

MOTORS

For Driving Cranes, Hoists, Pumps, Tools, and all Classes of Machinery.

CENTRAL STATION AND SHIP LIGHTING COMBINED PLANTS.

Prices and Full Particulars on application.

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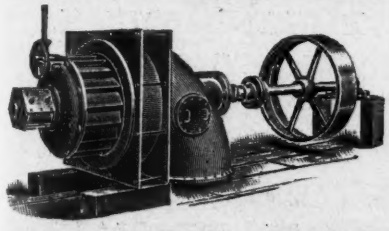
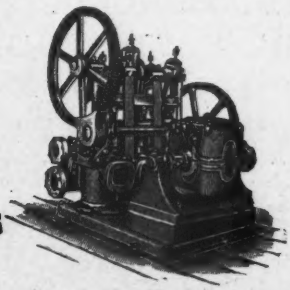
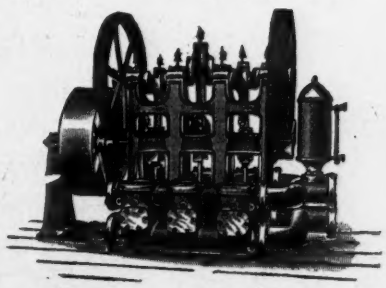
Telegrams: "McClure Whitfield, Stockport." Telephone No. 180 Nat.







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In great variety for Motor Driving.

Large Stock always on hand ready for immediate delivery.

THE "VICTOR" TURBINE, Horizontal Types a Speciality.

One Installation of 75,000 H.P. now in course of construction.

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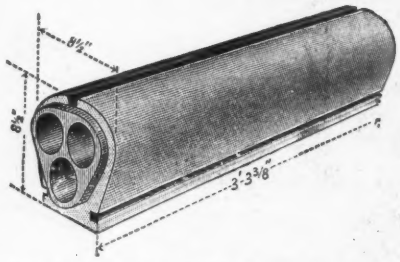
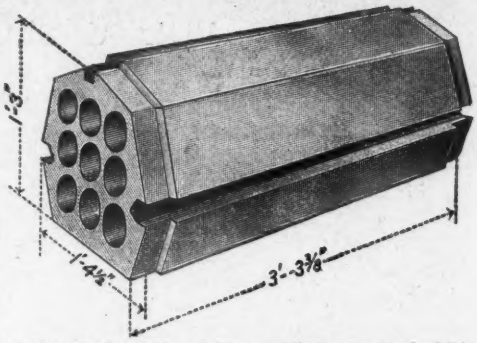
PATENT CONCRETE BLOCKS for UNDERGROUND ELECTRIC MAINS



THE BEST AND CHEAPEST FORM OF CONDUITS FOR ALL UNDERGROUND ELECTRIC WORK.



After a long experience it has been proved that the cement has no deleterious effect on lead or other cables, and the concrete of which the conduits are made matures and hardens when buried in the earth, and does not deteriorate.

The Blocks are manufactured to carry 3, 6, 9, 12, 16, 20, 24 and 30 Cables.

Prices and particulars can be obtained, and Samples seen, on application to:—

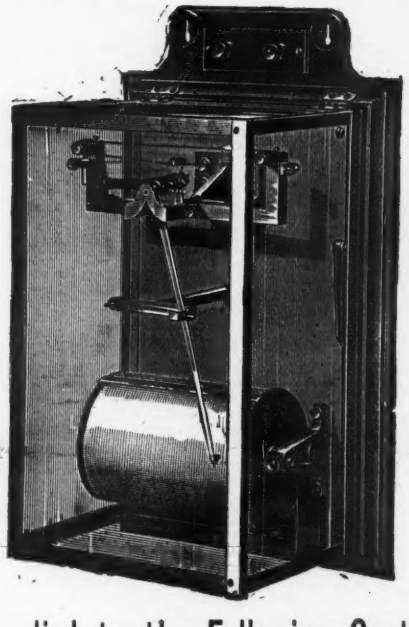
THE NATIONAL TELEPHONE COMPANY, LIMITED,

58, London Wall, E.C.; Telephone Buildings, Newhall Street, Birmingham; Telephone Buildings, Nelson Street, Bradford; Telephone Buildings, Upper Queen Street, Belfast; Telephone Buildings, Telephone Avenue, Bristol; New Street, Cardiff; 91, South Mall, Cork; Royal Exchange, Glasgow; F24, Exchange Buildings, Liverpool; Commercial Buildings, Leeds; 102, Portland Street, Manchester; 160, Pilgrim Street, Newcastle; Tuttle Hill, Nuneaton; Old Town Chambers, Plymouth; 14, Hanover Buildings, Southampton; Commercial Street, Sheffield.

7124

JAMES PITKIN'S

Recording Ammeters,



Recording Voltmeters,

Have been Supplied to the Following Central Stations:

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56, RED LION STREET, CLERKENWELL, E.C.

THE STRALSUND ARC LAMP FACTORY, Ltd.,

MANUFACTURERS OF

OPEN & ENCLOSED ARC LAMPS.

OUR LARGE ILLUSTRATED CATALOGUE for ARC LAMPS and their ACCESSORIES is NOW READY.

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KRUPKA & JACOBY,

CONTRACTORS TO H.M. GOVERNMENT,

61 & 62, Watling Street, Queen Victoria Street, LONDON, E.C.

Telegraphic Address:—"ACROMION, LONDON." Telephone:—BANK, 367.

"MOTO" SOLDERING TOOLS

ABSOLUTELY SAFE AND RELIABLE.

Designed for use in the Factory upon Armature connections and for General Purposes, Electric Light Installations, Tinsmiths, Packers, &c., &c. Made in sizes for bits 3 ozs., 11 ozs., 1¾ lbs.

Fullest Particulars and Prices from Messrs.

J. W. MANLEY & CO., 39, Victoria Street, S.W.

(LATE TASKER & SONS, Ltd.)

THE "KOKER" STOKER

COMBINED WITH

THE "MELDRUM" FURNACE.

MELDRUMS' and CLAYTON'S PATENTS.

Results of Tests on a Lancashire Boiler 27 ft. x 7 ft. 6 in.,

TWO FLUES 3 ft. dia.

ECONOMISER NOT USED DURING TESTS.

Duration of each test, 8 hours' continuous running. Heating surface of boiler, 846·5 sq. ft. Total grate area 30 sq. ft.

	Average 2 Tests.	Average 3 Tests.
Kind of coal used (Yorkshire)	Nuts at 7/10	Slack at 6/9
Total water evaporated per hour in lbs.	***8000 lbs.***	***8208 lbs.***
Water evaporated per sq. ft. of heating surface per hour	9·4 ,,	9·69 ,,
,, ,, ,, lb. of coal as fired	9·47 ,,	9·22 ,,
,, ,, ,, lb. (from and at 212° F.) as fired ...	***10·88 lbs.***	***10·61 lbs.***
Temperature of feed water entering boiler	102° F.	99° F.
Steam pressure in boiler (mean)	61 lbs.	62 lbs.
Weight of coal burnt per hour	850 ,,	889·5 ,,
Coal burnt per square foot of grate per hour	28·4 ,,	29·6 ,,
Percentage of heat transferred to water in boiler	69·7 %	72·74 %
Percentage of CO_2 in flue gases	12 %	12·4 %

Absolutely no smoke was made during the whole of the Tests.

MELDRUM Bros., Atlantic Works, Manchester

NALDER BROTHERS & THOMPSON, LIMITED.

(Managing Directors: F. H. NALDER and E. THOMPSON),

SUCCESSORS IN THE

AMMETER, VOLTMETER, AND SWITCH BUSINESS TO

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SOLE MAKERS OF THE

N.C.S. AMMETERS & VOLTMETERS.

6-INCH METAL DIAL

BRASS COVER,

TERMINALS AT BACK.

1900 Type.

JEWELLED BEARINGS.

ACCURATE, RELIABLE, HANDSOME.

MADE IN ENGLAND.

£1 12 UP TO 100 AMPS. £1 15 UP TO 160 VOLTS.

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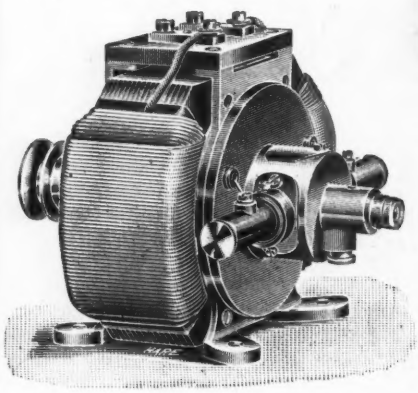
AGENTS:—Messrs. W. McGEOCH & Co., 108, Argyle Street Glasgow; Mr. S. JEVONS, Electric Stores, Minories, Birmingham; and Messrs, SIMON, BERRY & Co., 65, King Street, Manchester. a160



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Manufacturers of Specialities in

SMALL ELECTRO MOTORS

both Continuous and Alternating Currents.

SAMPLE STICK POST FREE.

ELMWOOD ELECTRICAL WORKS. LEEDS.

W. CANNING & CO., Birmingham,

MAKERS OF

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FOR

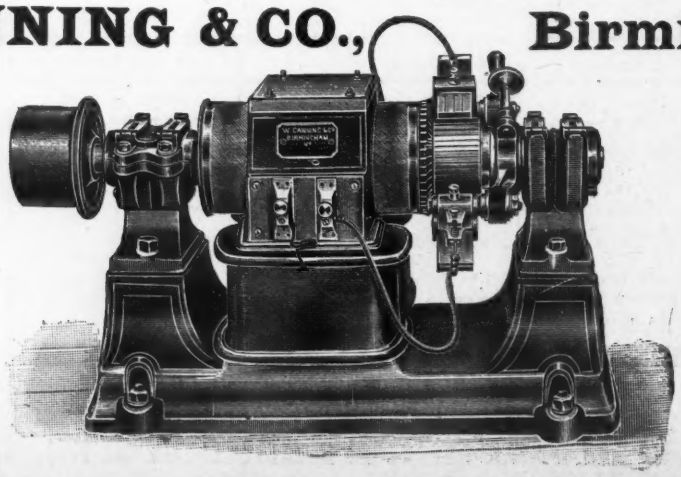
LIGHTING

AND

PLATING.

ELECTRIC MOTORS.

LISTS ON APPLICATION.



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LISTS ON APPLICATION.

ARTISTIC WALTHAM'S SWITCHES BELL PUSHES, etc.

COMPRISING QUAINT PANNELLED OAK ROOM and a MODEL DRAWING ROOM

FIVE SHOWROOMS AT

For the CONVENIENCE OF ELECTRIC LIGHT CONTRACTORS.

THE WALTHAM ART METAL & ENGINEERING CO., 46, York St., Buckingham Gate

Telegrams:—"Switchboard, London." (Near St. James's Park Station), LONDON, S.W.

NOW READY. Price 12s. 6d. Net. Post Free, 13s.

FOURTH YEAR. 1899-1900 EDITION.

MANUAL OF ELECTRICAL UNDERTAKINGS.

Compiled under the direction of

EMILE GARCKE, M.I.E.E., F.S.S.

Contains Particulars of about 1,000 Electrical Undertakings owned by Companies and Municipalities, Directory, Diagram, Map, and other Useful Data.

TO BE OBTAINED FROM

H. ALABASTER, GATEHOUSE & CO., 4, Ludgate Hill, E.C.

THE ELECTRICAL DEVELOPMENT AND FINANCE CORPORATION, Ltd.,

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Telegraphic Address: "Unipolar, London."
Telephone, No. 419, Westminster.

The objects of the Corporation are the development and financing of approved Electrical and Industrial Undertakings of all kinds. 1248

Official Notices.

1901—MAY TO NOV.—1901.

GLASGOW INTERNATIONAL EXHIBITION.

Patron—
HER MOST GRACIOUS MAJESTY THE QUEEN.

Vice-Patron—
His Royal Highness THE PRINCE OF WALES.

President—
The Right Hon. THE LORD BLYTHSWOOD-OF BLYTHSWOOD.

Chairman of the Executive Council—
The Hon. Sir DAVID RICHMOND, Lord Provost of Glasgow.

Vice-Chairmen—
JOHN SHEARER. JAMES HUNTER DICKSON.

Chairman of the London Hon. Consultative Committee—
The Right Hon. THE LORD MAYOR.

The Classification includes:—Agriculture and Mining; Industrial Design and Manufactures; Machinery, Motive Power, Electricity, and Labour-Saving Appliances; Locomotion and Transport; Marine Engineering and Shipbuilding; Science, Education, and Music; Sports. Women's Section:—Fine Art, Scottish History, and Archæology Loan Collection.

The Site of the Exhibition is the West End Park of the City, extending to 67 Acres. The population of the City and Surrounding District exceeds 1,500,000, and the Tourist Routes to the Highlands of Scotland radiate from Glasgow. The Exhibition of 1888, on Same Site, was visited by 6,000,000 Persons. Prospectus and Application Forms can be obtained on application, and must be filled up and returned on or before 1st June, 1900.

H. A. HEDLEY, *General Manager.*
36, St. Vincent Place, Glasgow. 6792

Official Notices.

CITY & COUNTY OF NEWCASTLE-UPON-TYNE

ELECTRIC TRAMWAYS.

To Contractors and Others.

THE CORPORATION OF NEWCASTLE-UPON-TYNE is prepared to receive Tenders for the Laying Down in Newcastle of about 11 Miles of Double-Line Tramway, the rails and fastenings and the poles being supplied by the Corporation. On payment of £3 3s. to the City Treasurer (which will be returned on receipt of a *bonâ fide* tender), Specifications, Bills of Quantities, and Forms of Tender may be obtained, and Plans and Drawings inspected at the office of the City Engineer, Town Hall, Newcastle, on and after Wednesday, January 3rd, 1900; and tenders, addressed to "The New Tramways Committee," must be sent in on before Wednesday, January 24th, at noon. The Committee does not bind itself to accept the lowest or any tender.

By order,
HILL MOTUM,
Town Clerk.

Newcastle-upon-Tyne,
December 19th, 1899. 7288

URBAN DISTRICT OF ILFORD.

ELECTRIC LIGHTING.

THE ILFORD URBAN DISTRICT COUNCIL are prepared to receive Tenders for the supply and erection of the following plant:—

Section A.—Water-tube Boilers with Fittings, Economiser, Feed Pumps, &c.
,, B.—Pipework, &c., in Engine and Boiler House.
,, C.—Two 200-kilowatt and One 100-kilowatt Steam Dynamos, and Motor Boosters (Vertical Enclosed High-speed Engines).
,, D.—Storage Batteries.
,, E.—Main Switchboard and Connections.
,, F.—Overhead 15-ton Engine-room Travelling Crane.
,, G.—Underground Mains, Conduits and Roadwork for Private and Public Lighting.
,, H.—Arc Lamps and Posts.
,, K.—Station Lighting.

Persons tendering are at liberty to tender for any Section or Sections, or for the whole of the Sections, but not part of one Section.

Tenders will be considered from those firms only with plant of similar size and type working satisfactorily in other electricity supply works.

Copies of the Specification, with Forms of Tender, General Conditions and Plans, may be obtained at the offices of the undersigned, on and after December 12th, on depositing a cheque for Five Guineas, which sum will be returned on receipt of a *bonâ fide* tender. Applicants to state the Section, or Sections, for which they propose tendering.

The works are to be carried out in accordance with the Plans and Specifications prepared by Mr. W. C. C. Hawtayne, of 9, Queen Street Place, London, E.C., Consulting Engineer to the Council, from whom further information can be obtained on and after December 12th, 1899.

Tenders, sealed and marked "Tender for Electric Lighting," to be addressed to "The Chairman of the Urban District Council," at the Council Offices, Ilford, and to be delivered on or before 12 o'clock noon on January 20th, 1900.

The Council do not bind themselves to accept the lowest or any tender.

J. W. BENTON,
Clerk to the Council.

Council Offices, Ilford,
December 6th, 1899. 7286

OFFICIAL NOTICES continued on Sup. VIII.

Official Notices.—Continued.

URBAN DISTRICT OF BARKING TOWN

ELECTRIC LIGHTING.

CREEKSMOUTH EXTENSION.

THE BARKING TOWN URBAN DISTRICT COUNCIL are prepared to receive Tenders for the supply and erection of the following Plant:—

Section A.—Two Continuous Current Transformers and Switch Gear.
,, B.—Underground Cables and Roadwork.

Persons tendering are at liberty to tender for either or both sections, but not part of one section. Tenders will be considered from those firms only having plant of similar type, doing similar duty elsewhere.

Successful tenderers will be required to enter into a contract to pay the trades union rates of wages, and to recognise trades union hours of labour.

Copies of the Specification, with Forms of Tender, General Conditions, and Plan of Mains, may be obtained at the offices of the undersigned on and after January 8th next, on payment of Five Guineas, which sum will be returned on receipt of a *bonâ fide* tender.

The works are to be carried out in accordance with the Specifications and Plans prepared by Mr. W. C. O. Hawtayne, M.I.E.E., 9, Queen Street Place, London, E.C., Consulting Engineer to the Council, at whose office Plans can be inspected (but not obtained) on and after January 8th, 1900.

Tenders, sealed and marked "Tender for Creeksmouth Extension," to be addressed to the Chairman of the Urban District Council, at the Council Offices, Barking, and to be delivered on or before 12 o'clock noon, on JANUARY 23rd, 1900.

The Council do not bind themselves to accept the lowest or any tender.

(Signed) EDWIN H. LISTER,
Clerk to the Council.

Public Offices, Barking,
December 22nd, 1899.

7229

SALFORD SCHOOL BOARD.

ELECTRIC LIGHTING.

THE BOARD are prepared to receive Tenders for the electric lighting of their new schools in Grecian Street North, Lower Broughton.

Copies of the Specification, and Form of Tender, &c., may be obtained only from the undersigned, upon payment of Two Guineas, to be returned upon receipt by the Board of a *bonâ fide* tender.

Specification and Plans may be seen at, and any further information obtained from, the offices of the consulting engineers, Messrs. Lacey, Clirehugh & Sillar, at 78, King Street, Manchester, and 2, Queen Anne's Gate, Westminster, London.

Sealed Tenders, addressed to the Chairman of the Board, and endorsed "Tender for Electric Lighting," must be delivered to the undersigned not later than noon on MONDAY, JANUARY 8th, 1900. The Board do not bind themselves to accept the lowest, or any, tender.

OGILVIE DUTHIE,
Clerk to the Board.

School Board Offices,
Chapel Street, Salford,
December 16th, 1899.

7287

BOROUGH OF TYNEMOUTH CORPORATION.

TENDERS are invited for Free Wiring of premises in connection with the Corporation Electricity Works.

C. TURNBULL,
The Borough Electrical Engineer, Tynemouth.

7230

Mr. J. G. LORRAIN, M.I.E.E., M.I.M.E., &c
Fellow of the Chartered Institute of Patent Agents.
Norfolk House, Norfolk St., London, W.C.
"PATENTEE'S HANDBOOK" Post Free on Application. 118

BELLISS & MORCOM, Ltd.,
BIRMINGHAM.
QUICK-REVOLUTION ENGINES
For ELECTRIC LIGHTING, POWER and TRACTION.
See Illustrated Advertisement Alternate Weeks.

THE BRITISH THOMSON-HOUSTON CO., Ltd.,
83, Cannon St., London, E.C.,
ELECTRICAL ENGINEERS AND CONTRACTORS.
SEE LARGE ADVERTISEMENT IN LAST WEEK'S ISSUE

THE
Electrical Review
Published Every Friday, Price 4d.
Office: 4, LUDGATE HILL, LONDON.

To be obtained by order from any Newsagent in Town or Country

NOTICE TO ADVERTISERS.

The following are the LATEST times up to which Advertisements can be received for publication in current week's issue:—

New Advertisements or Alterations to existing ones, Wednesday 12 noon.

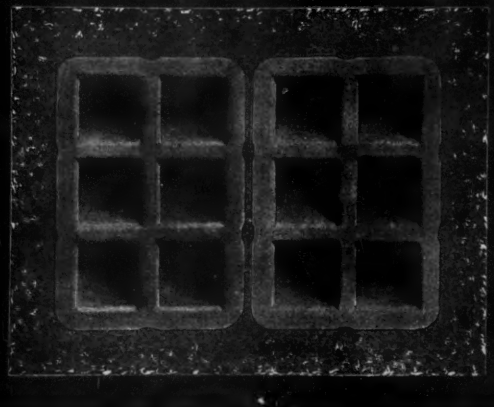
Small Announcements for middle pages, Thursday 2 p.m.

REFERENCE BOOK OF
TABLES & FORMULAS
FOR
ELECTRIC STREET RAILWAY ENGINEERS.
ARRANGED AND COMPILED BY
A. E. MERRILL.
Author of Electric Lighting Specifications for the Use of Engineers and Architects.

In the pages of this book are collected the principal tables and formulæ of which the electric street railway engineer makes use in his practical everyday work, arranged in the most convenient manner for practical use.
Only those tables and formulæ in daily use, and which are for the most part complete in themselves, have been inserted. A logical order has been followed in the arrangement, beginning with the steam plant and passing successively through cars and their equipment, overhead work, track work, and miscellaneous tables and formulæ in constant use. A number of the tables and formulæ are original while many others have been modified and extended to adapt them to the conditions imposed in electric street railway work.

London: H. ALABASTER, GATEHOUSE & CO.,
4, LUDGATE HILL, LONDON.

Doulton Conduits
For Underground Feeders in connection with
Electric Traction.
DOULTON & CO., LIMITED.
LAMBETH, LONDON, S.E.



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For use in connection with . . .

Central Lighting Stations — Auto Cars
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Electric Bells — Electric Locomotives — Phonographs
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REPLATING OTHER TYPES OF CELLS

USED IN OVER 150 LIGHT AND POWER STATIONS

A Few of the Power Stations using Chloride Cells

HALIFAX
LIVERPOOL
ST. HELENS
LEEDS
DOUGLAS and LAXEY
SNAEFELL
RAMSEY
BOOTLE
BLACKPOOL
FLEETWOOD
CENTRAL LONDON RAILWAYS
NEW YORK MET. CO.
PHILADELPHIA
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BALTIMORE
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WASHINGTON
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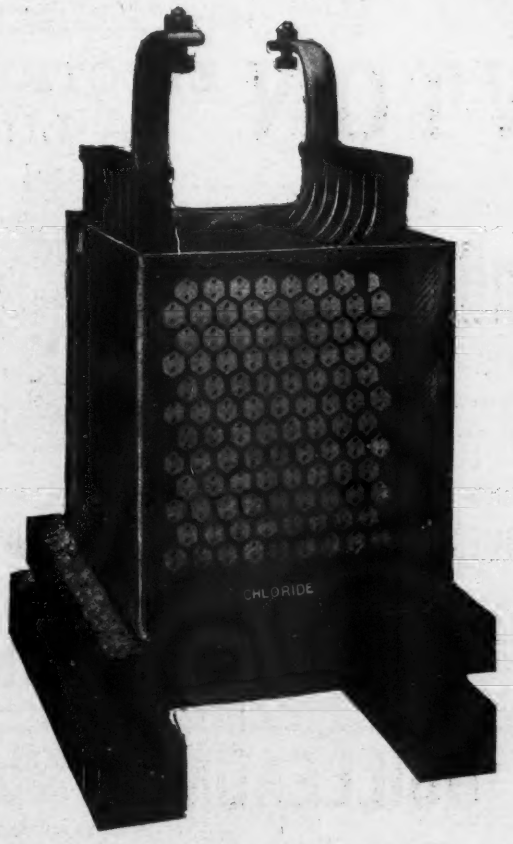
NEW BRUNSWICK
BUFFALO
NEW HAVEN
BUENOS AYRES
ROCHESTER
CHICAGO
RIVER POINT
PAWTUCKET
CAMDEN



Standard Cell in Glass Box

A Few of the Lighting Stations using Chloride Cells

MANCHESTER
BOLTON
STAFFORD
NEWPORT
MORLEY
CANTERBURY
LINCOLN
STOCKPORT
CARLISLE
BRIGHOUSE
GALWAY
BATTERSEA
BARKING
NEWCASTLE
LEIGH
BEXHILL
PEMBROKE
CHICAGO
ST. LOUIS
HARTFORD
PHILADELPHIA
BOSTON
SAN FRANCISCO
LOWESTOFT
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FOR LISTS, &c., APPLY TO THE - - -

CHLORIDE ELECTRICAL STORAGE SYNDICATE, LIMITED...

...London Office....
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Clifton Junction
MANCHESTER.

VULCANIZED RUBBER CABLES.

THE ST. HELENS CABLE CO., Ltd.,

WARRINGTON.

PATENT.

"DAVY ENCLOSED ARC LAMPS."

The Only Perfectly Enclosed Arc Lamp.
No Sealing or Outer Globe Required.
Arc is Hermetically Sealed.
No Gases can Escape into Room.
Has Only One Controlling device.

HORSELL ROAD WORKS,
Ronald's Road, Highbury, LONDON, N.
Telegrams: "Arcazon, London."
Telephone No. 256 Dalston.
Sole Agents for Great Britain and Ireland
Messrs. VENNER & CO., *6, Old Queen Street, Westminster, S.W.*

ROSS COURTNEY & Co., Ltd.

Ashbrook Road,
LONDON, N.

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SMALL TURNED PARTS, STAMPINGS, &c.,
MADE TO ORDER.
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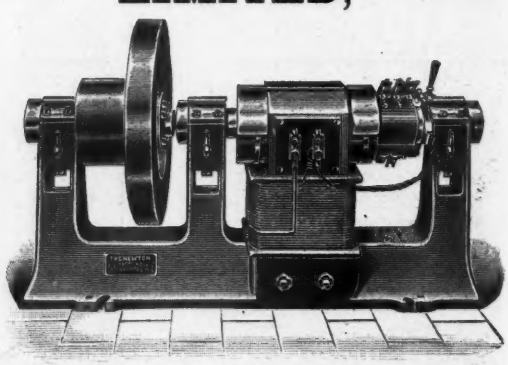

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Telephone:—No. 129, HAMMERSMITH,

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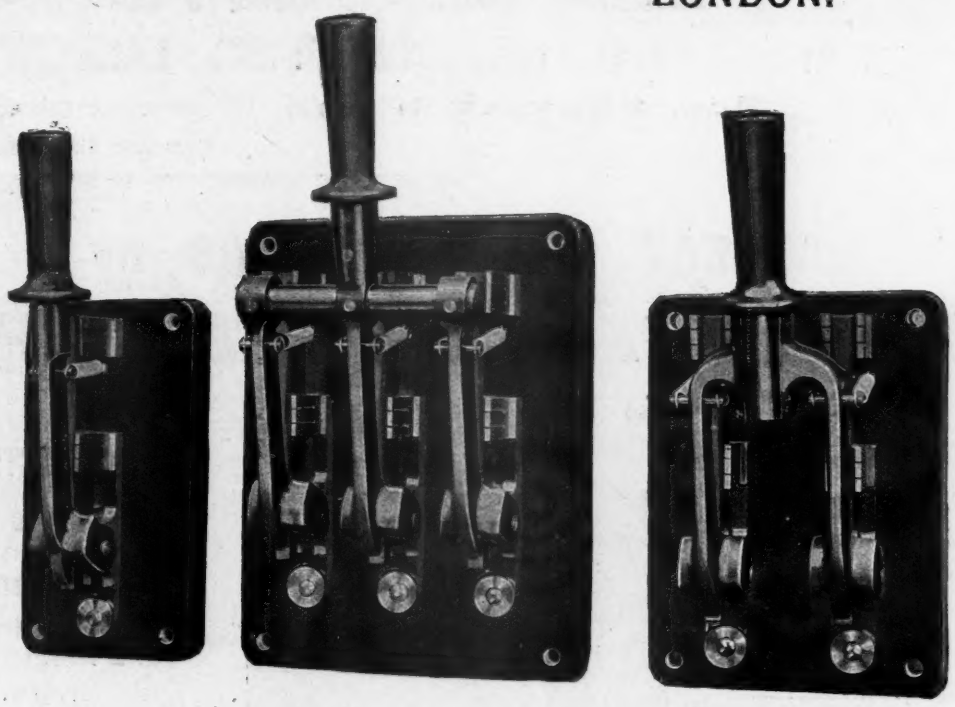

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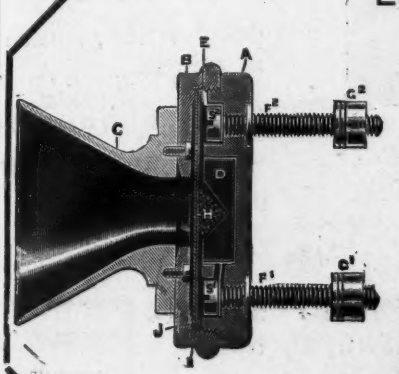

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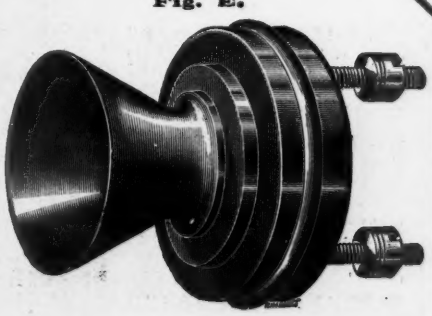

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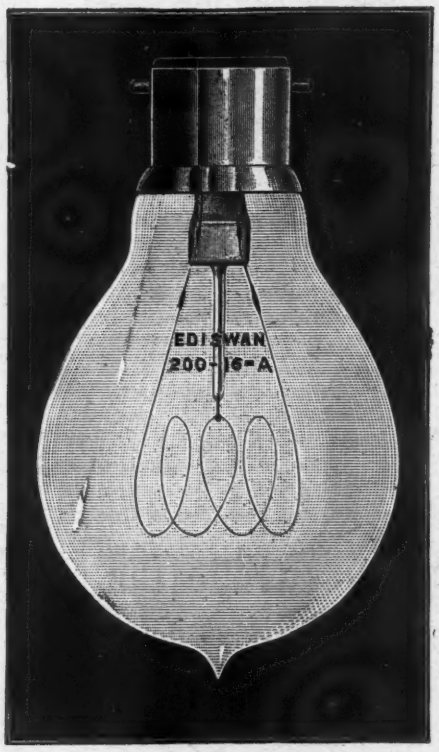

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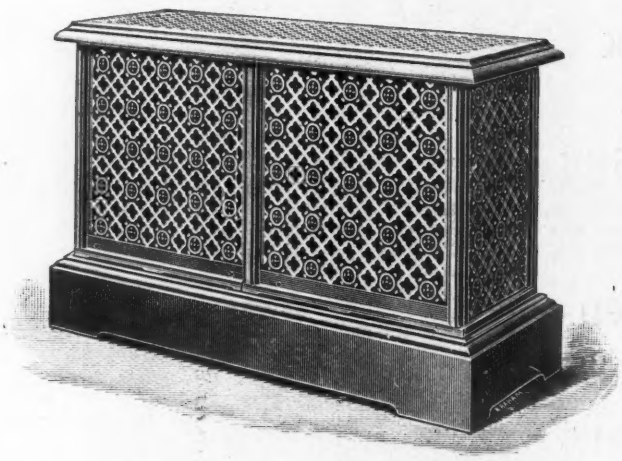

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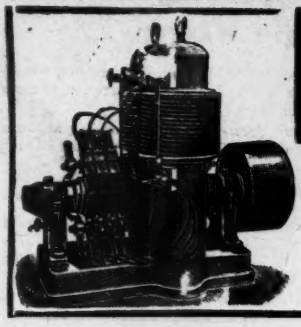

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If letters are not to be delivered to certain firms or individuals (if known), instructions to that effect should be sent to the Manager of the ELECTRICAL REVIEW, who will do his best to carry out such instructions. Letters of applicants cannot in such cases be returned to them, nor can the names of advertisers using a number or a *nom de plume* in any way be disclosed.

Original Testimonials should never be sent.

THE BRITISH ELECTRIC TRACTION COMPANY, LIMITED.

DISTRICT SUPERINTENDENT FOR SOUTH WALES.

MR. SUGRUE having accepted a position in the service of the Company at Head Office, the Company are prepared to receive Applications for the above Appointment.

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Applications, accompanied by three testimonials, to be addressed to the undersigned, and sent in on or before Thursday, January 4th, 1900.

ARTHUR ELLIS,
General Manager. 7333

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(*Continued on next page.*)

SITUATIONS VACANT.—*Continued.*

DRY Batteries.—Wanted, Practical Man well up in dry cell manufacture; also with knowledge of primary cells generally. Permanency to good man.—Address, 7331, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 7331

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REQUIRED at once, Storekeeper in firm of electrical engineers and dealers; a good salary given to reliable and trustworthy man. Must have had previous experience.—Reply by post to 7225, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 7225

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WANTED, by a large firm of electrical contractors, a Superintendent for their Glasgow branch; must have had good experience in estimating and supervision of men, also knowledge of working drawings. Some local connection desirable.—Apply, stating age, salary expected, &c., to 7325, c/o ELECTRICAL REVIEW, 4, Ludgate Hill, London. 7325

WANTED, by established firm in the Midlands, good Engineer as Works Manager to control drawing office and works, and to be responsible for quick manufacture of dynamos and motors, one who has, or is, occupying similar position preferred; must be up-to-date and energetic.—Reply, in confidence, with full particulars and salary required, to Box 826, Sell's, 167, Fleet Street, London, E.C. 7309

WANTED by the Wireless Telegraph and Signal Company, Limited, Junior Assistants well up in electrical science. Those with a good knowledge of Hertsian work and acquainted with practical telegraphy preferred.—Apply in the first instance, by letter only, to 28, Mark Lane, E.C., stating age, qualifications, and salary expected. 8742

WANTED, Jointer accustomed to street junction and service boxes for London alternating station, 9½d.—7322, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 7322

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WANTED.—Smart young man to manage small works, making continuous current dynamos and motors; must be used to control men, and understand designing. Good opening for energetic man.—Apply, stating wages required, age, experience, &c.; applications treated in strictest confidence.—7308, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 7308

WANTED.—Working Foreman for small cable factory; state full particulars as to age, wages and experience.—7268, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 7268

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ELECTRICIAN seeks charge of installation work or plant; 20 years' experience in house and ship lighting, and with steam, oil, and gas engines. Good mechanic.—Address, 7342, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 7342

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WIREMAN, Practical, wood or Simplex, fix well, surface.—5, Tarrant Street, W. 7333

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(Continued on next page.)

FOR SALE.—*Continued.*

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SECOND-HAND Plant for Sale.—A large number of Meters, Arc Lamps, Transformers, complete Switchboard, a small Bumstead & Chandler Engine, and 100-KW. E.C.C. Alternator, are for sale, owing to change to direct current.—Apply, Electricity Works, Woolwich, S.E. 7306

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ARTICLES WANTED.—*Continued.*

WANTED.—Electric Lamp Tops and Scrap Platinum.—EDEY AND Co., 29, Ludgate Hill, London. 6725

WANTED.—Shunt-wound dynamo, 70 volts 20 amperes. State speed, maker's name, and lowest price.—7335, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 7335

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NOTICE.—To Wiring Contractors and Wiremen. The Simplex Steel Conduit Company, Limited, of Coventry Street, Birmingham, beg to give notice that at the request of a number of contracting firms, they now register the names of wiremen and foremen wiremen who have experience with the Simplex Steel Conduit system. Wiremen possessing this qualification are invited to enter their names in our register, on a form to be supplied by the company. Contractors applying to us for experienced men will have a list of names submitted to them. The Company make no charge for the above registration. 6030

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With Outer Globe.

To Burn Singly
On 200 Volt Circuit taking
2½ Amps.,
Or Two in Series
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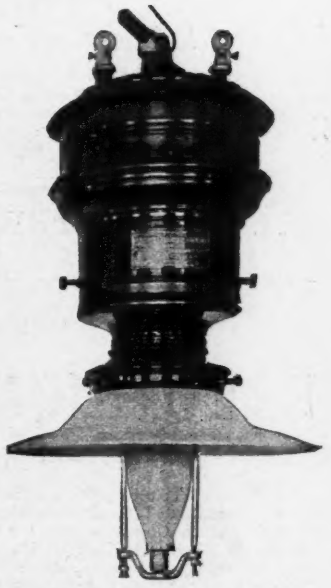

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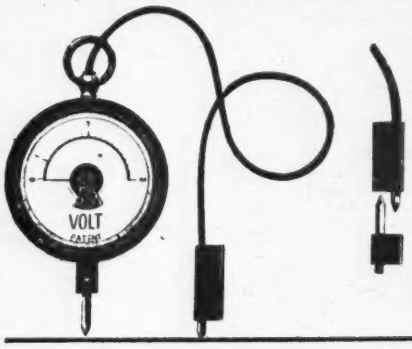

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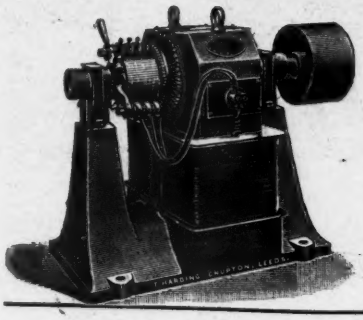

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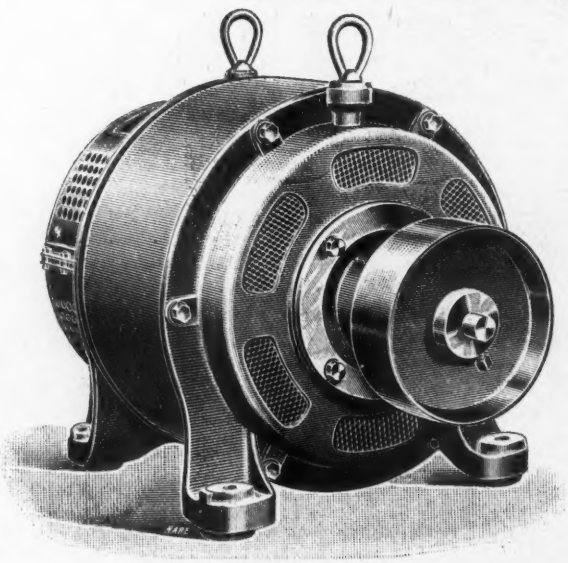

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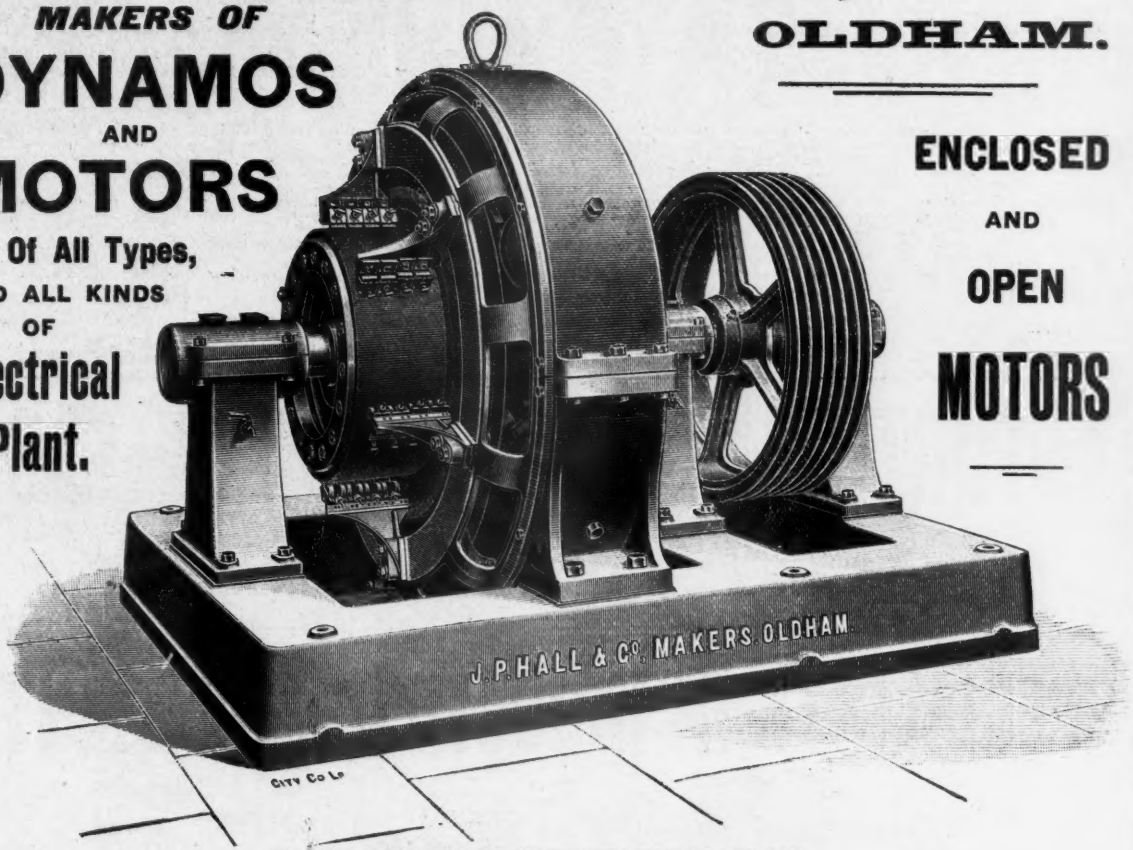

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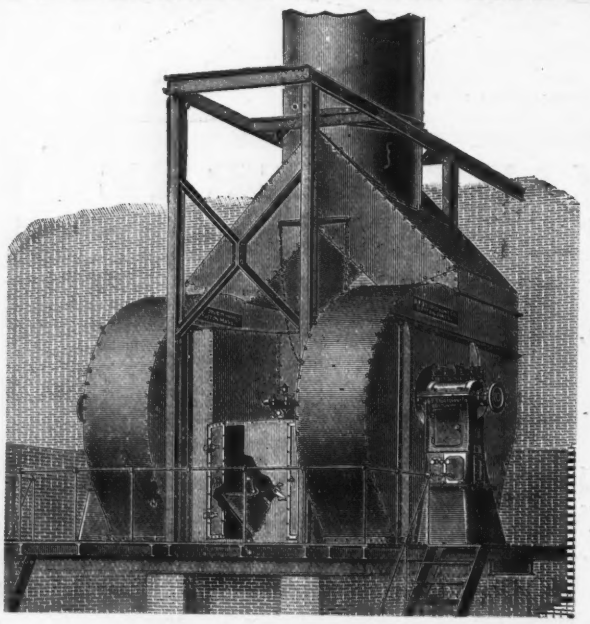

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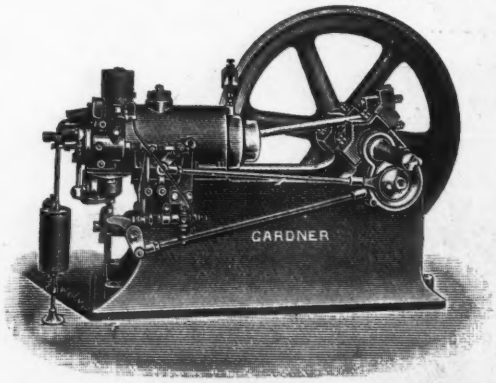

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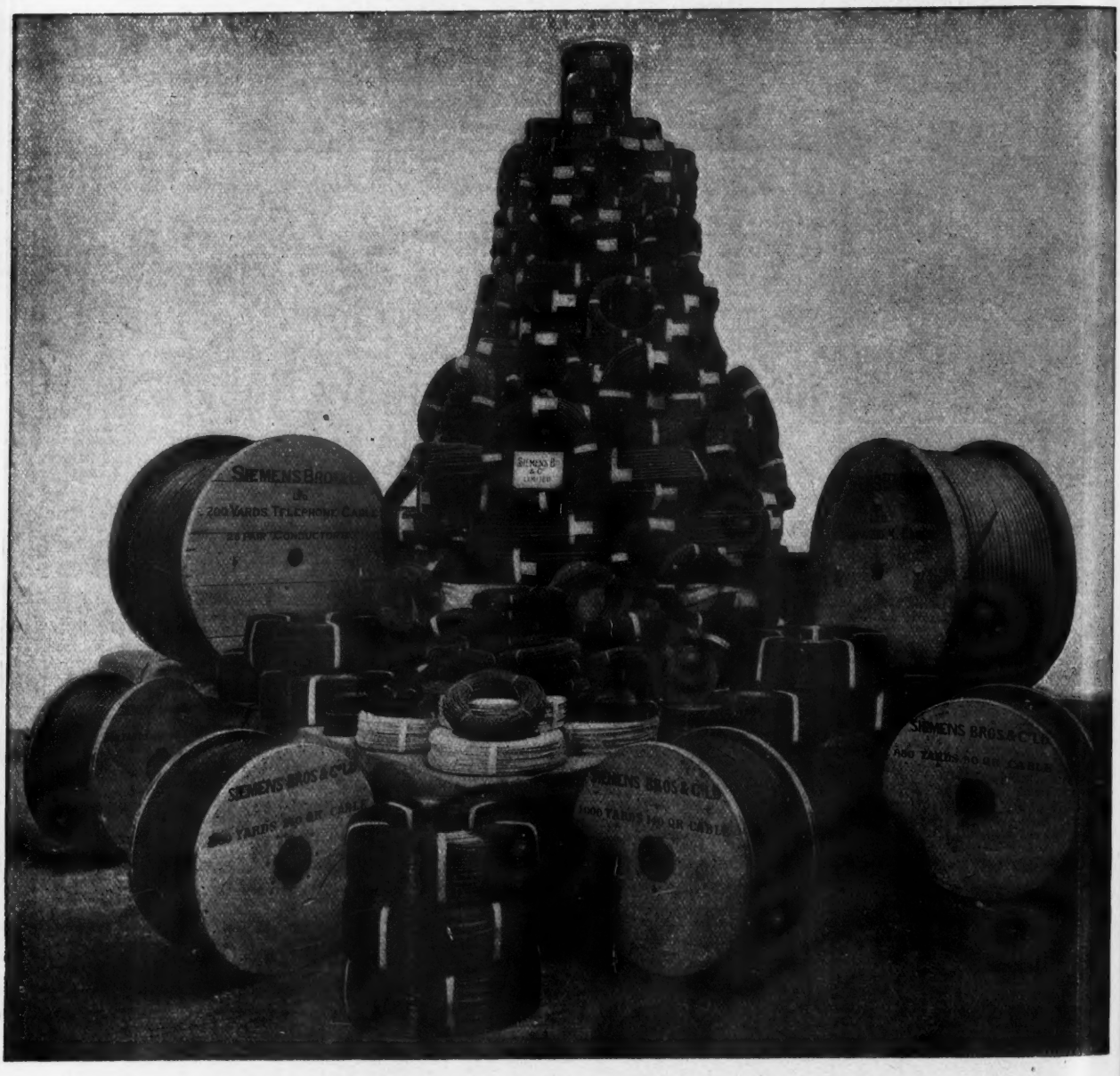

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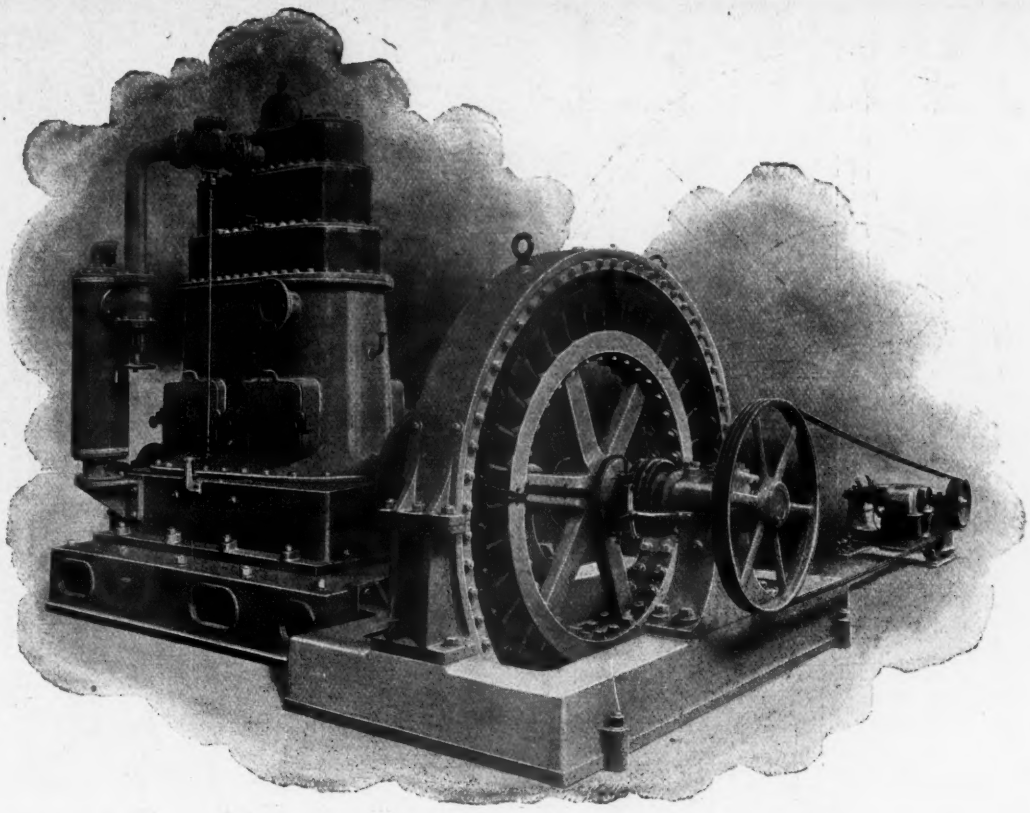

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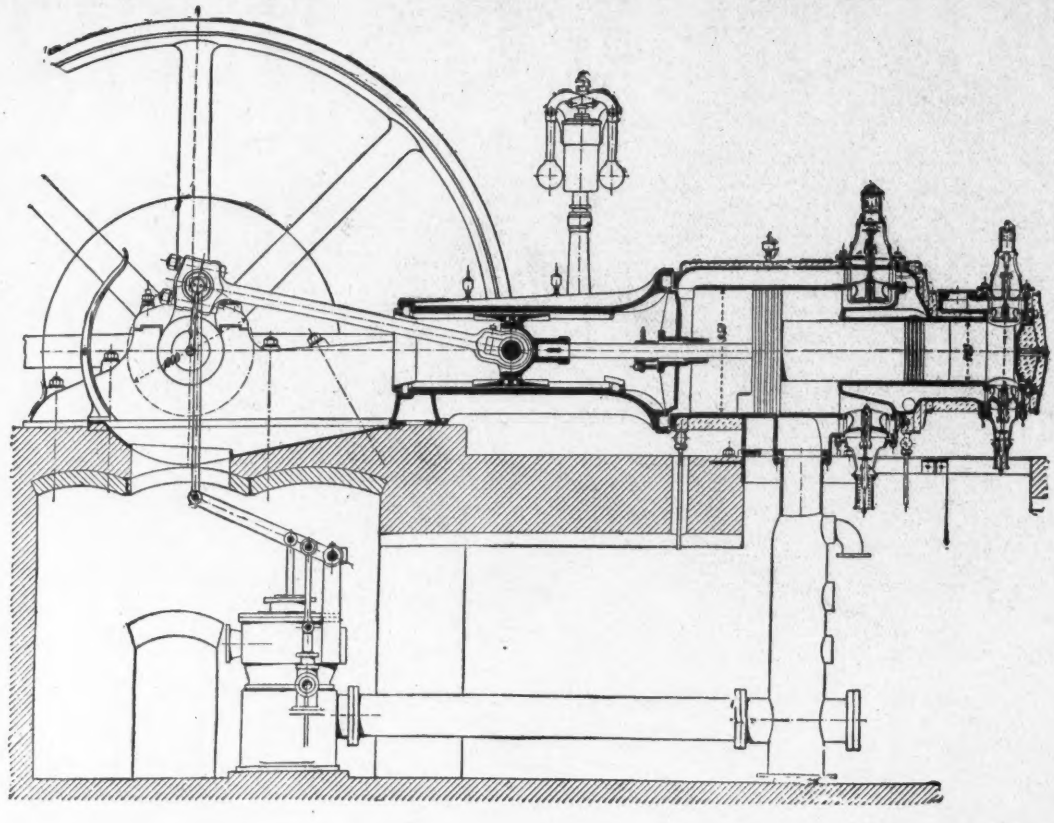

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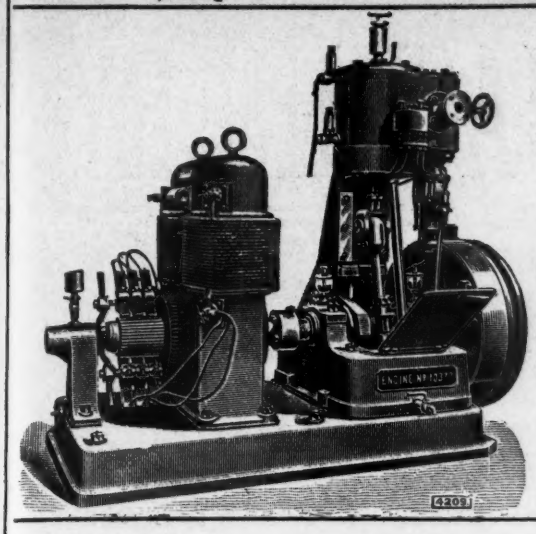

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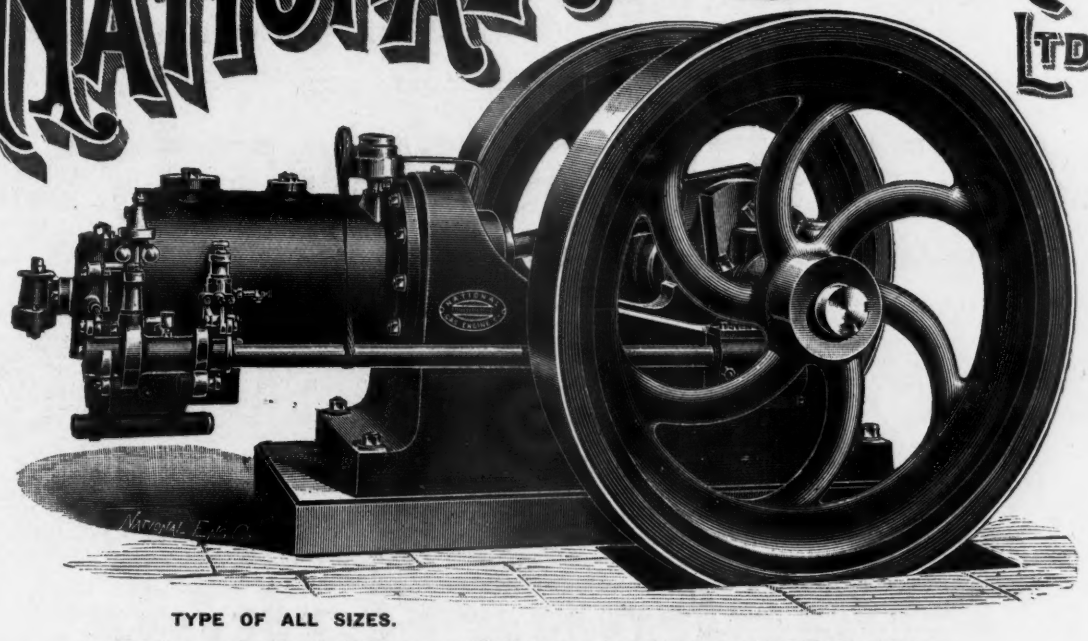

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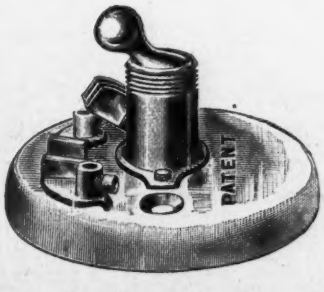

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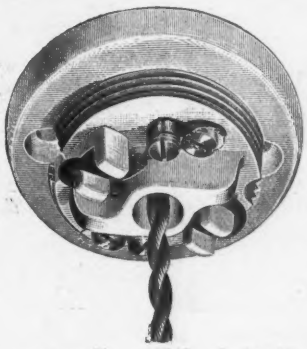

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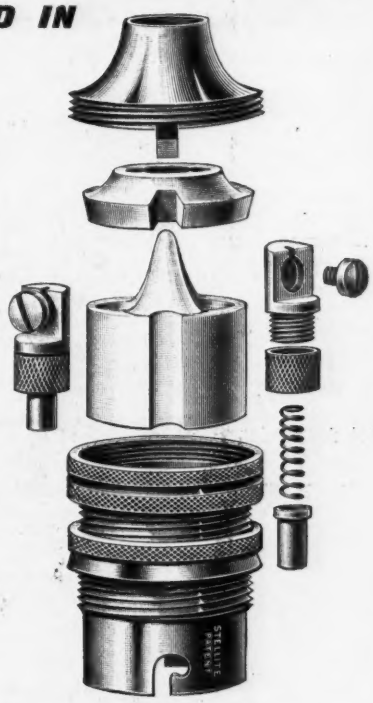

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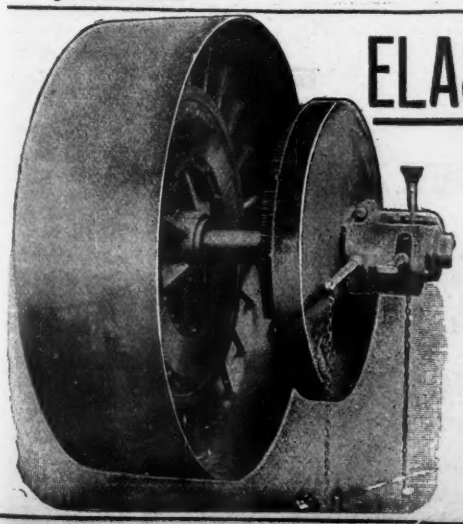

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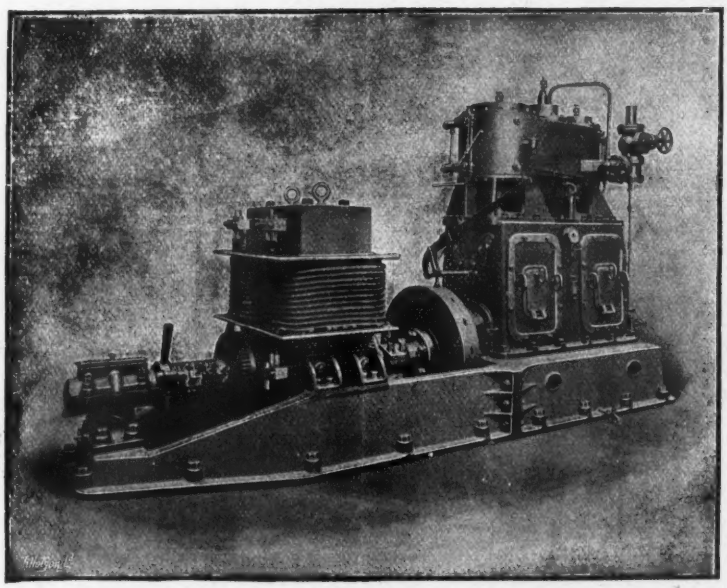

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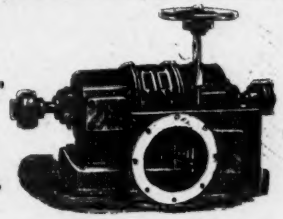

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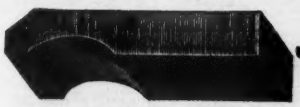

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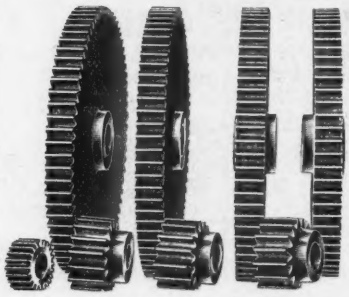

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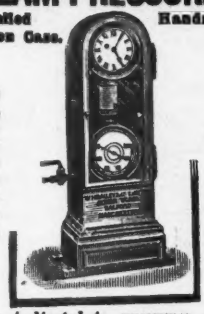

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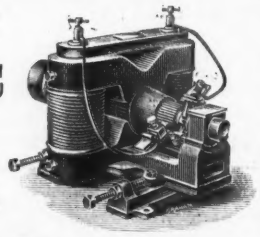

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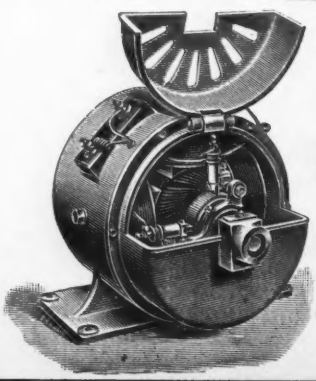

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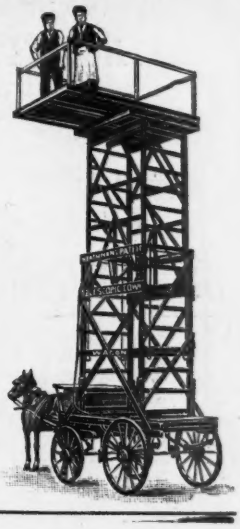

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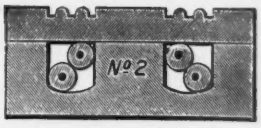

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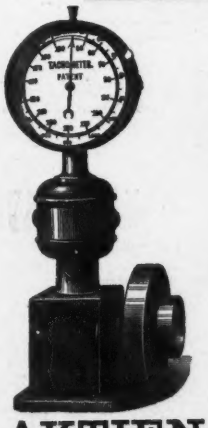

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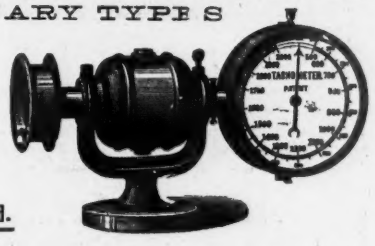

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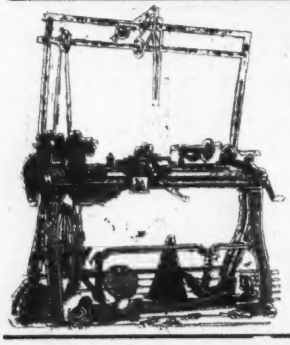

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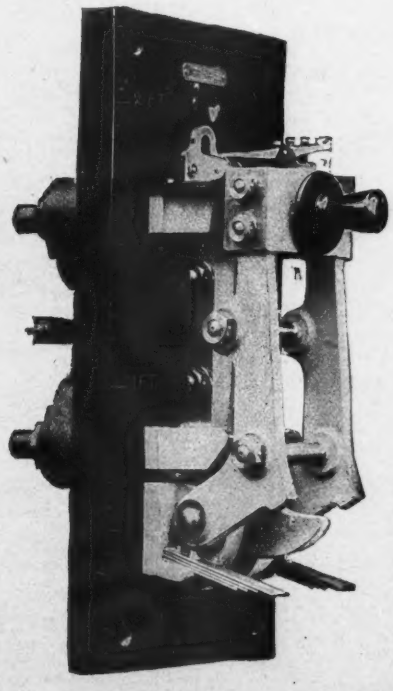

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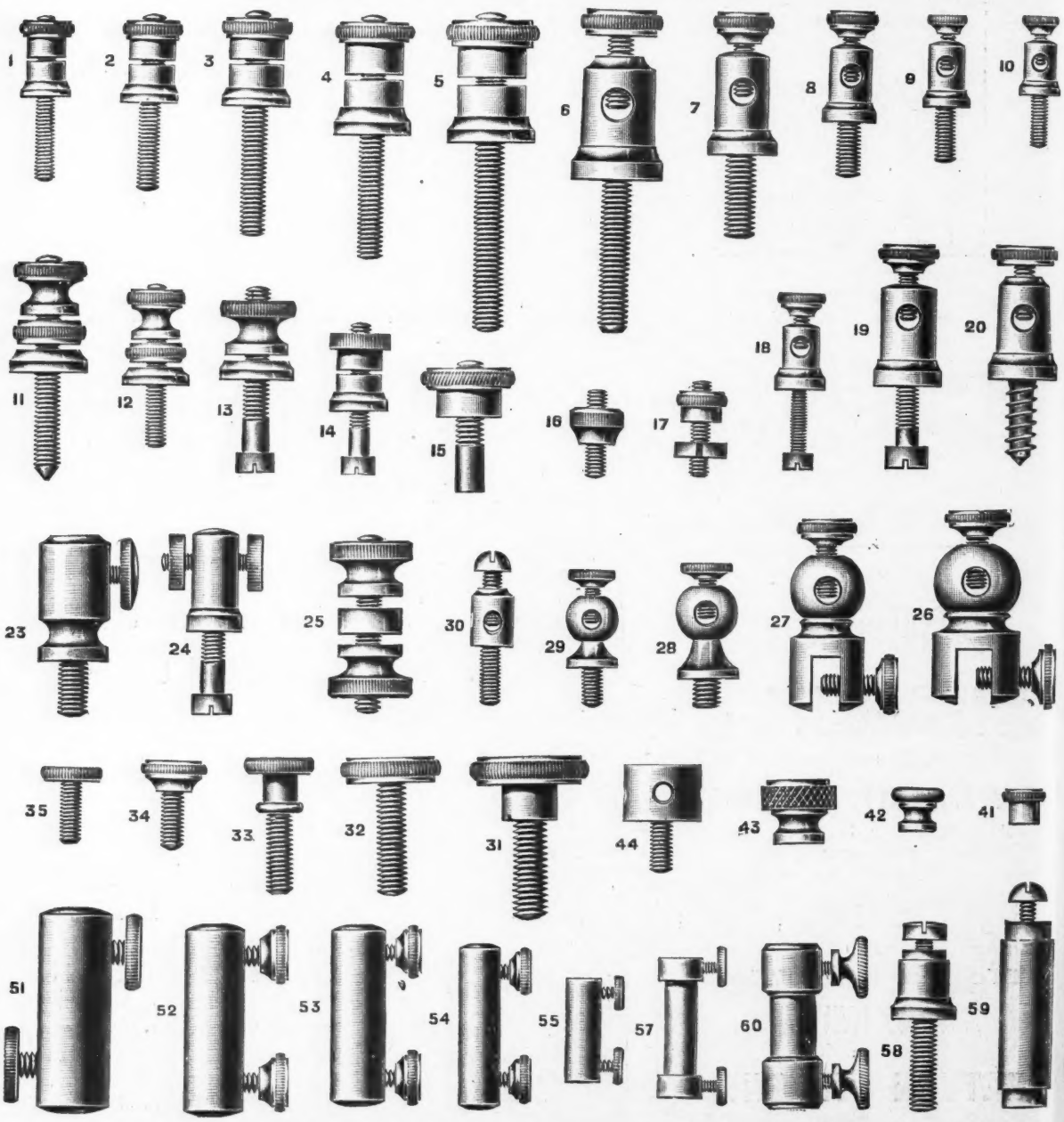

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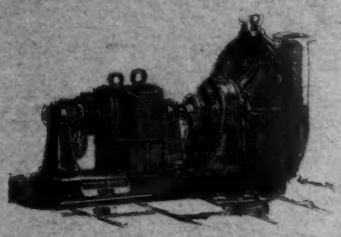

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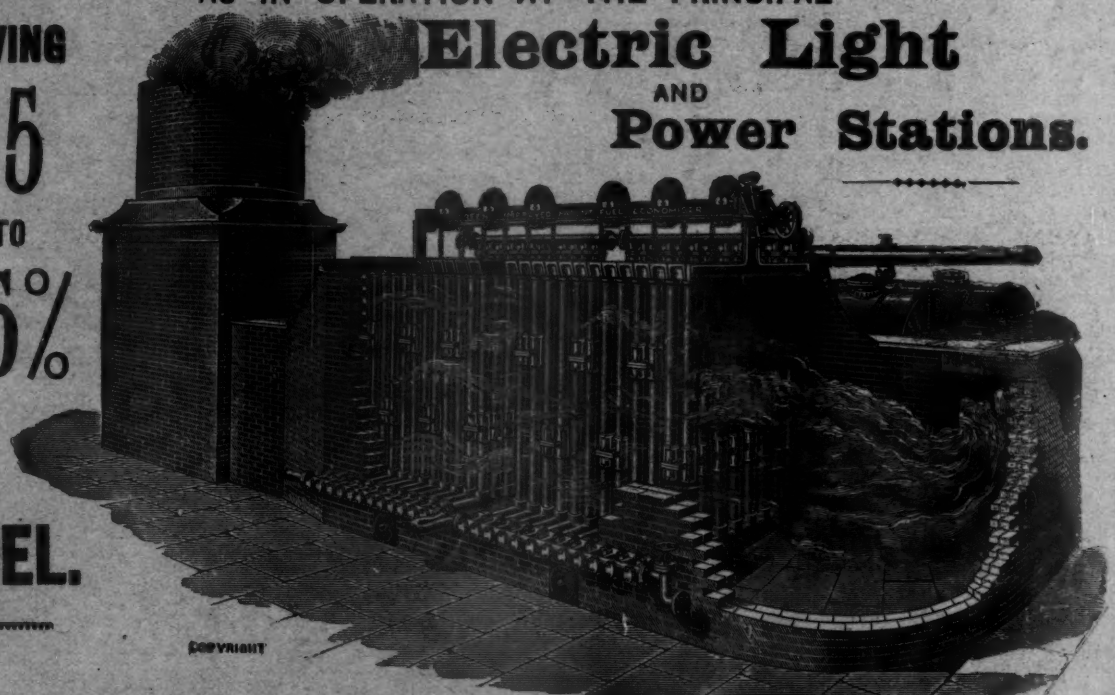

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Printed by W. G. Wooden, 7, 8 & 9, Hosier Lane, E.C., and Published by the Proprietors, H. Alabaster, Gatehouse & Co., at 4, Ludgate Hill, London.